INTERAVIA

REVIEW OF WORLD AVIATION

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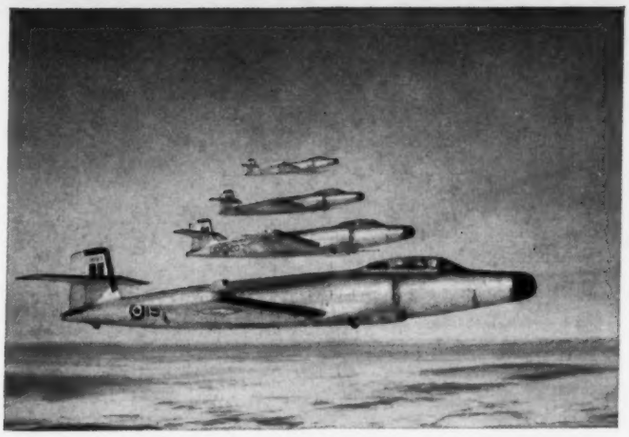
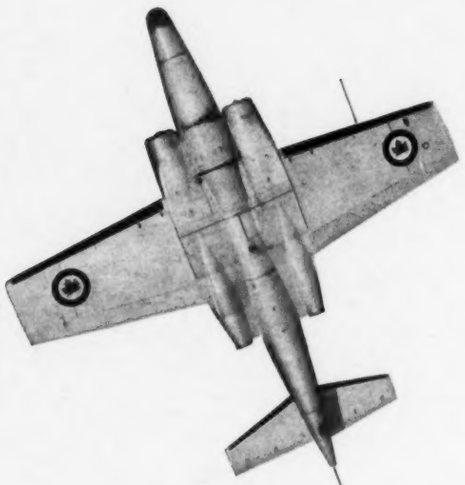
Spaceships, Satellites...

VOLUME X 7 JULY 1955

CF-100's in formation on winter patrol over Canada's Northern approaches.



. . . in England now



Three CF-100 all-weather interceptors recently flew the Atlantic and are now on evaluation tests with the R.A.F. in England.

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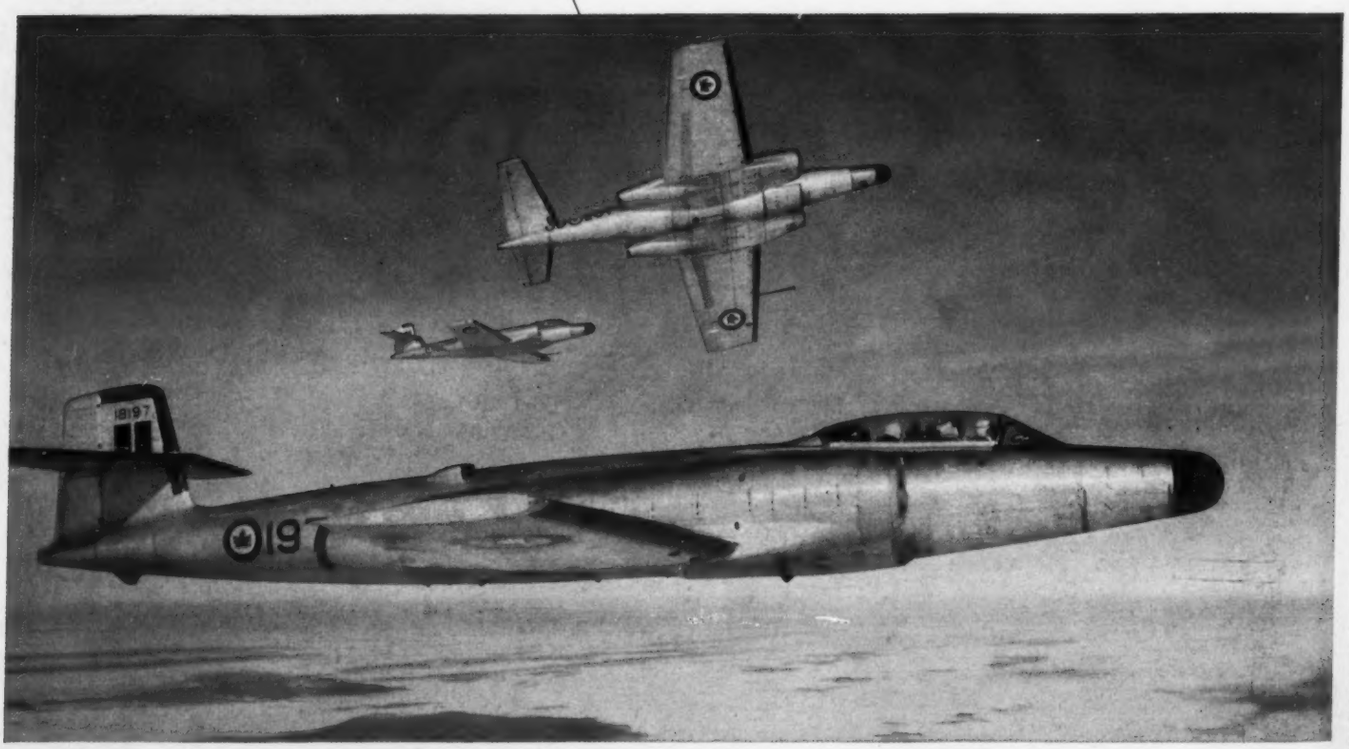
Three CF-100's flew the Atlantic in March and four R.C.A.F. squadrons will be on duty over Europe in 1956.



INTERAVIA

Review of World Aviation

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Front Cover :

Walt Disney Studio's spaceship on its way to the moon. Picture Walt Disney Productions.

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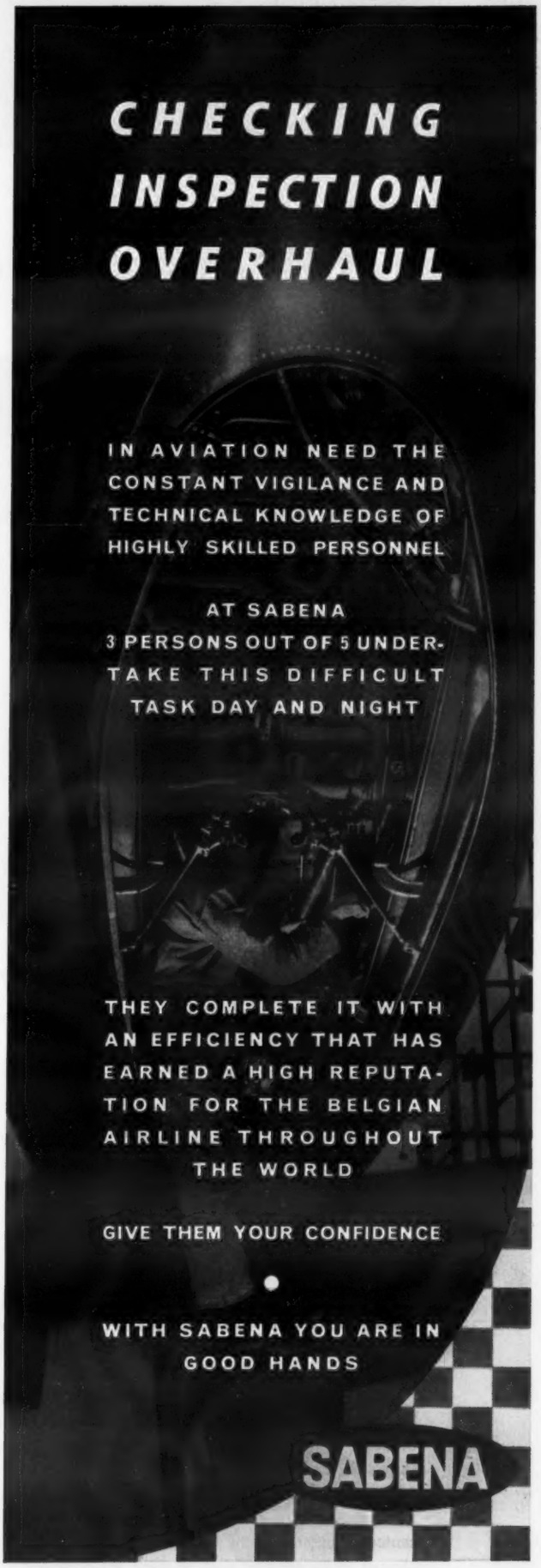
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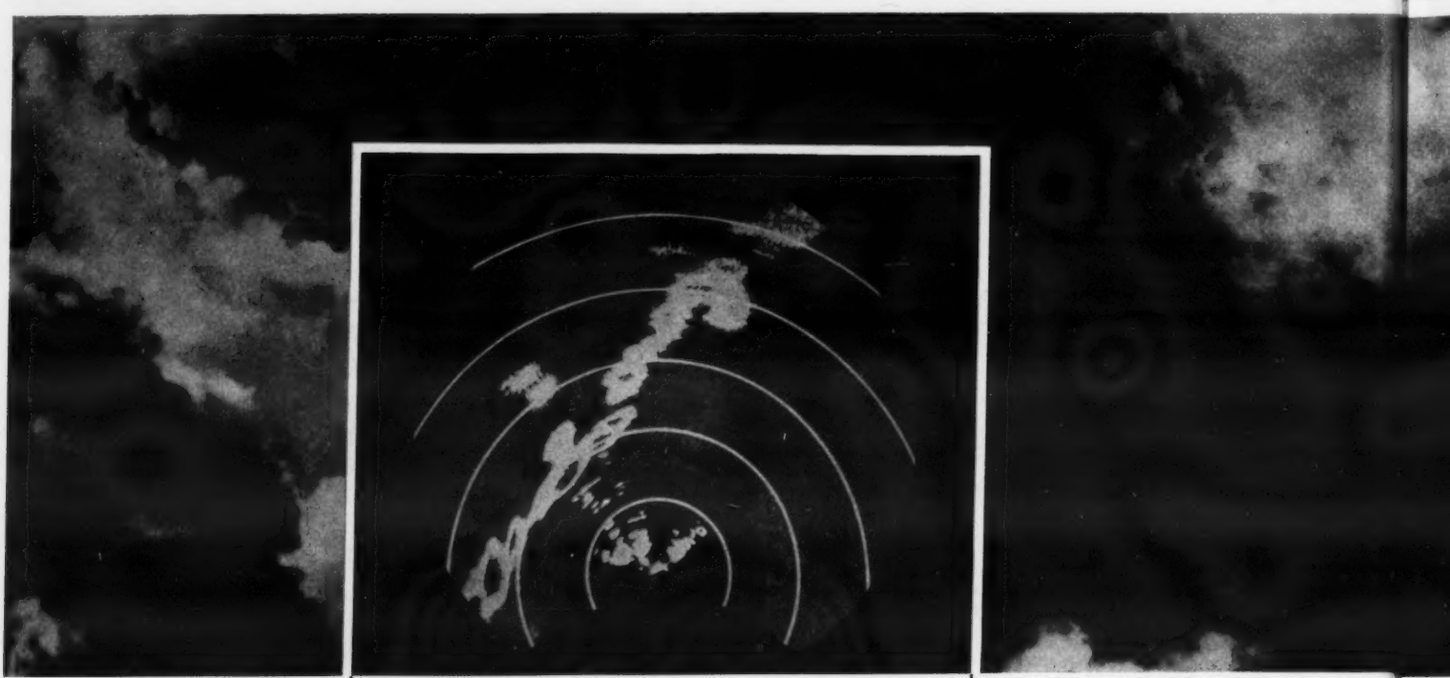

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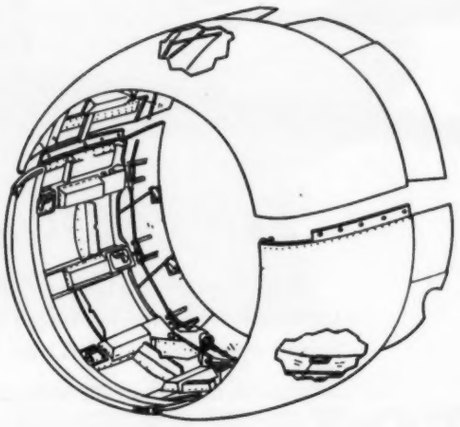

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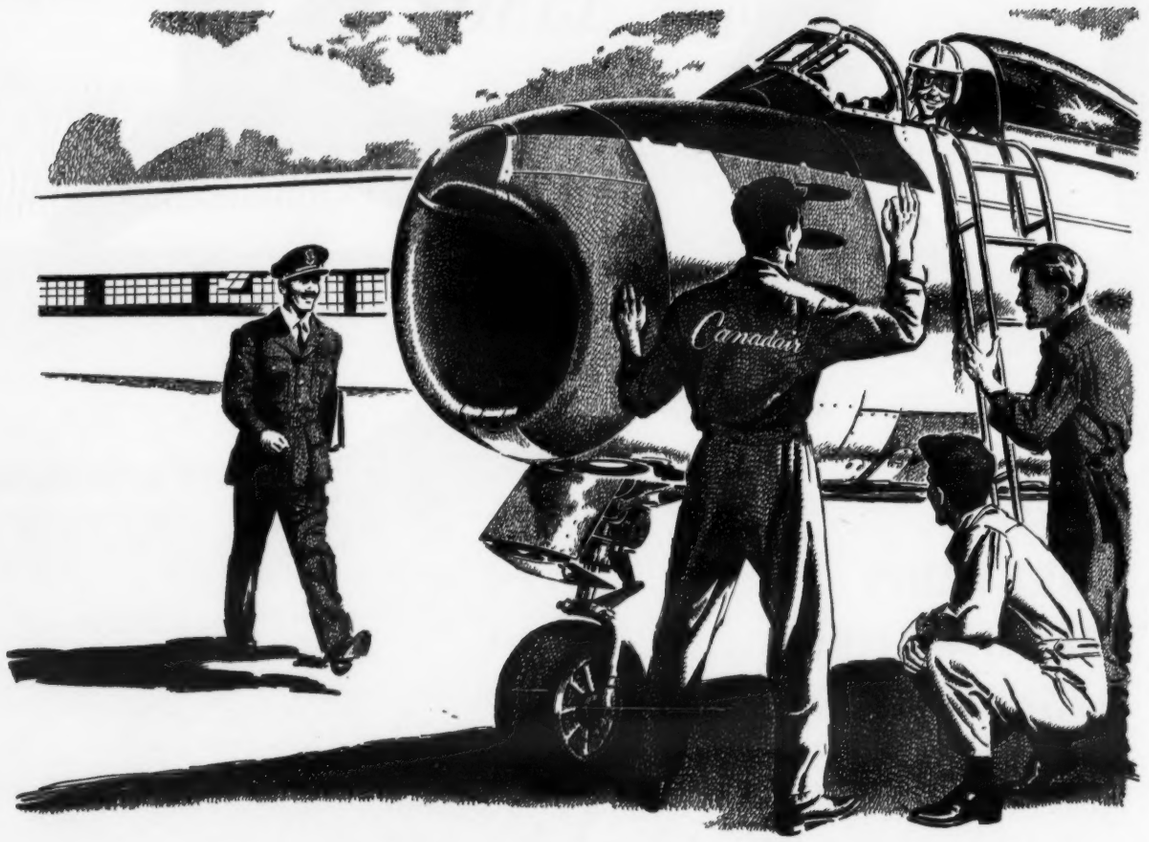

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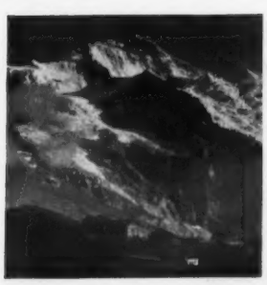

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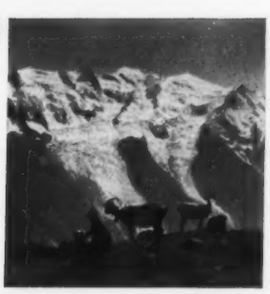

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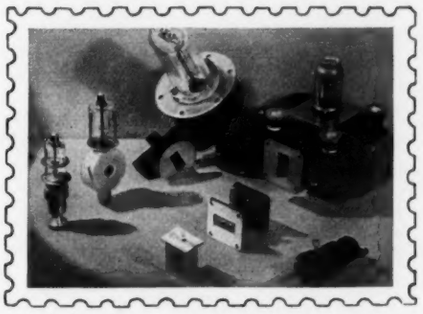

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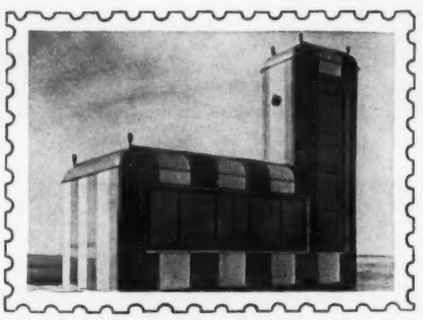

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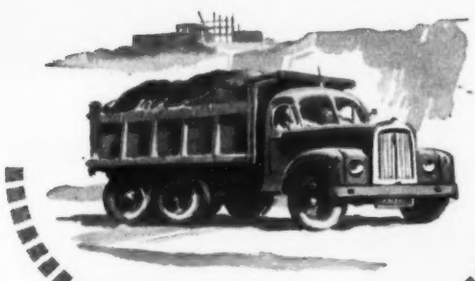

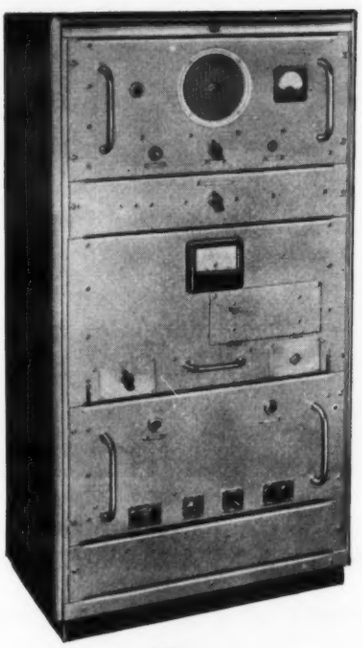

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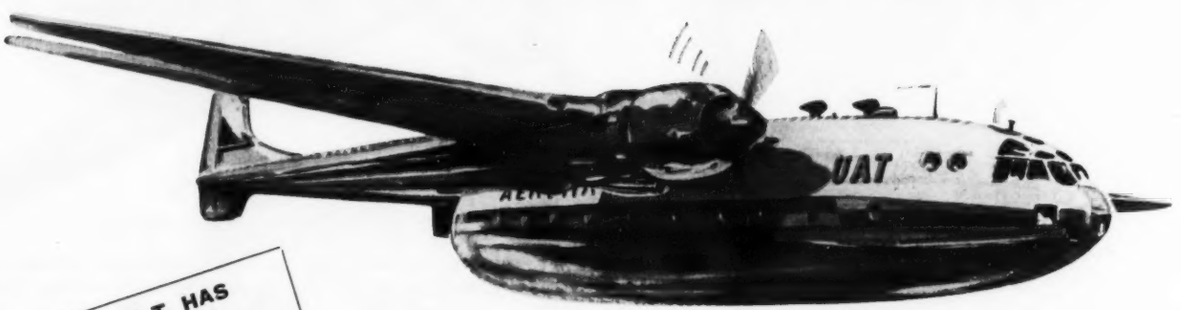

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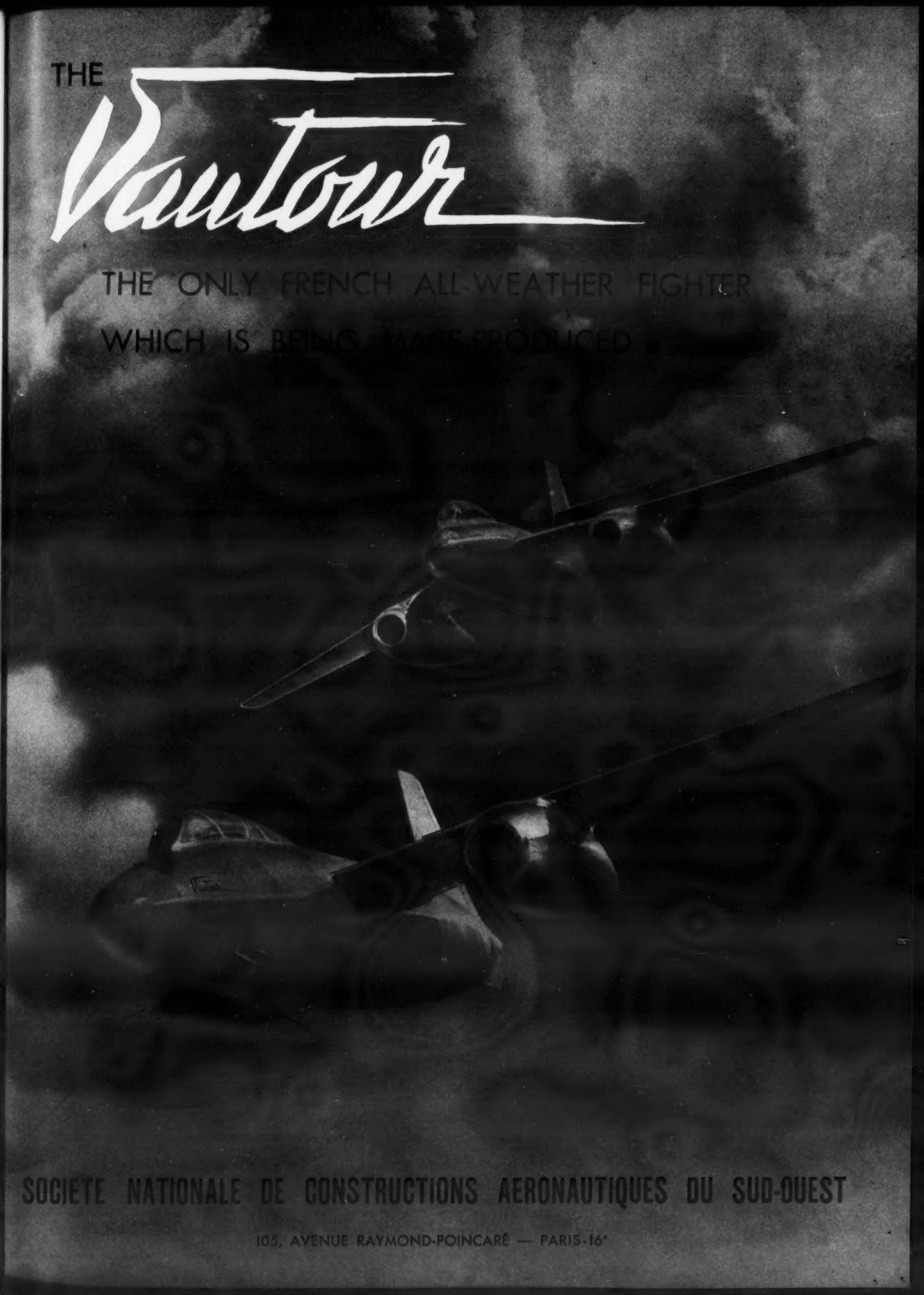
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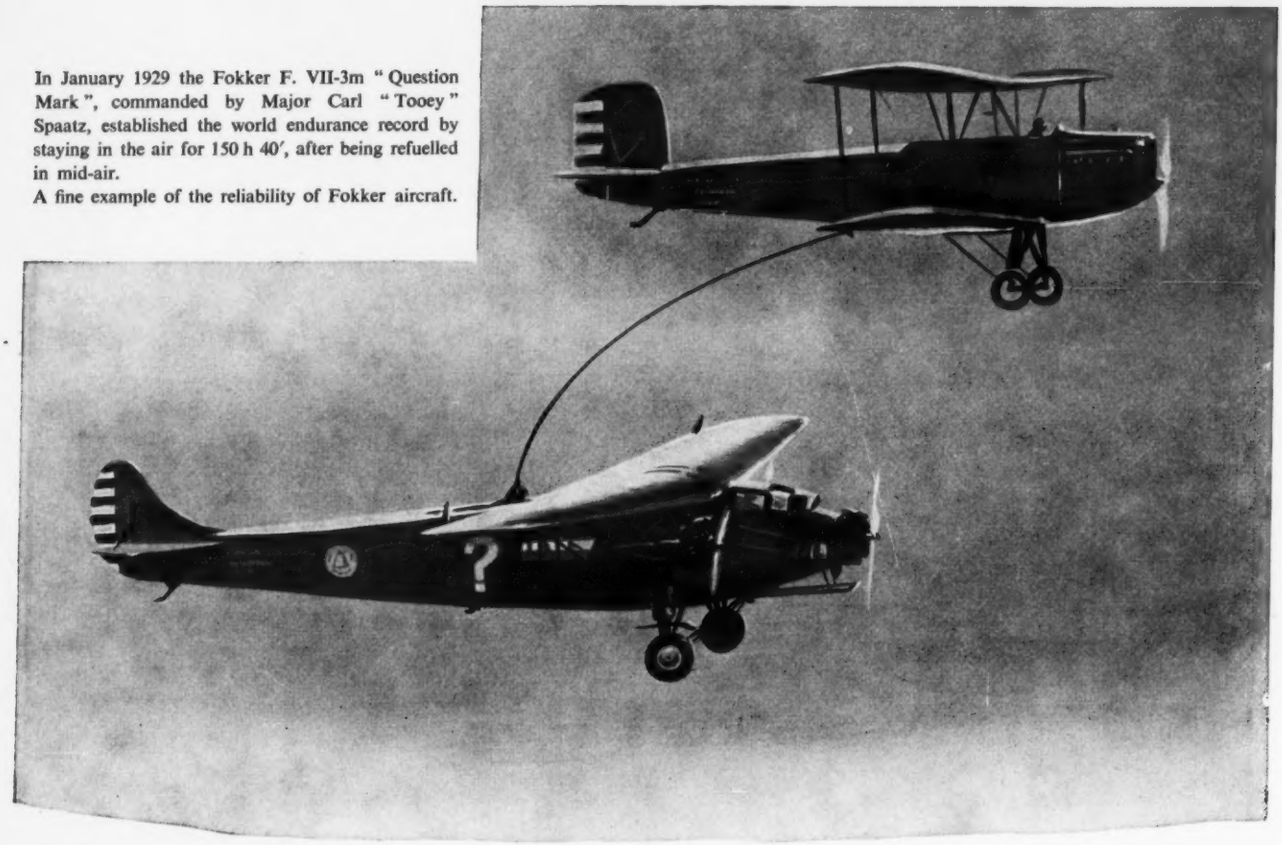
A fine example of the reliability of Fokker aircraft.

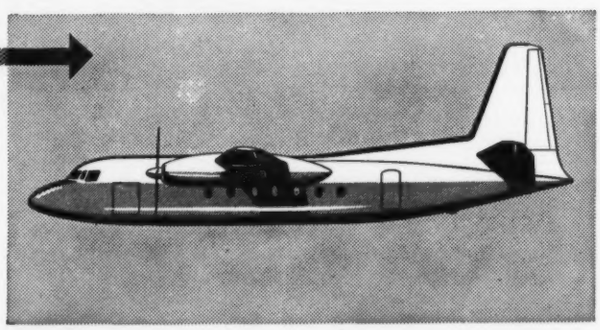


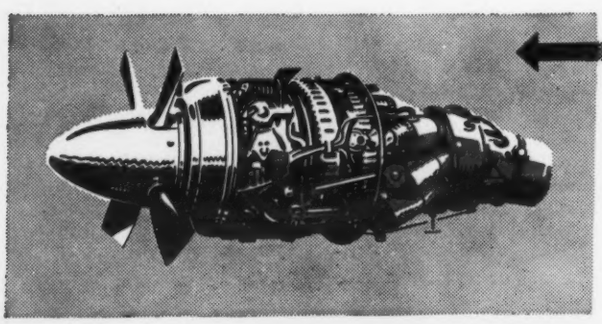
PIONEERS IN THE PAST — Fokker — PIONEERS IN THE FUTURE

FOKKER WILL SPAN THE WORLD AGAIN!

THE NEW FOKKER F. 27 "FRIENDSHIP"

twin-turboprop airliner for 28-36 passengers in which more than 35 years of experience in commercial aviation is incorporated, is the most suitable transport for short to medium range traffic available, meeting both ICAO and CAR 4b requirements.





THE ROLLS-ROYCE "DART" TURBOPROPS

with which the "Friendship" is powered are the most reliable propeller-turbines available for this type of aircraft. They allow economical operation in all climates and safe and vibrationless flight at 20,000 ft.

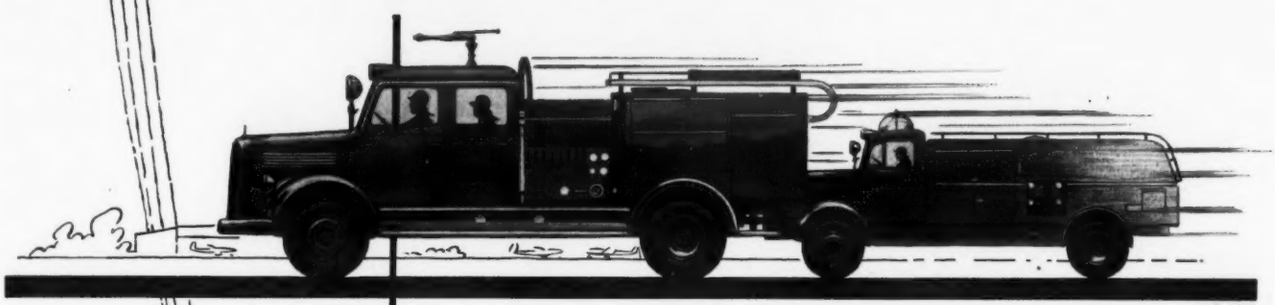
* * *

ROYAL NETHERLANDS AIRCRAFT FACTORIES FOKKER

SCHIPHOL-ZUID

TEL. ADDR.: FOKPLANES-AMSTERDAM

Seconds count



MLF 5502

Airport fire services must count every second, as the briefest time lost may multiply the risks of a fuel fire. In their race with time they gain a decisive advance over the fire with Mercedes-Benz-Metz special airport vehicles.

The rapid starting of the diesel engines in these modern vehicles, their quick get-away and their high max. speeds enable their up-to-date fire-fighting equipment to be employed with lightning speed at any point on the airport. Difficult terrain does not hamper them, as their rugged construction and robust, reliable engines render them independent of surface unevennesses.

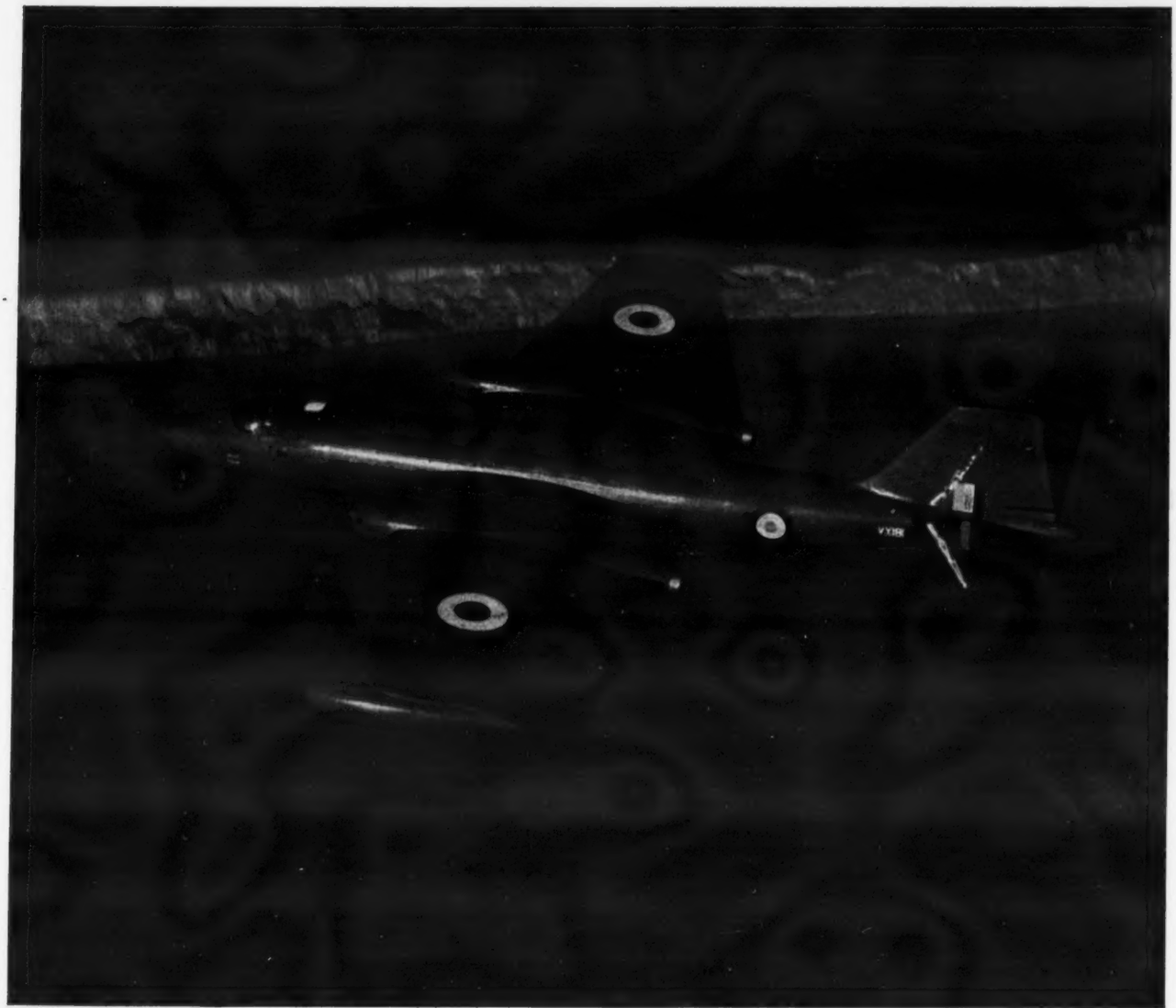
Speed due to the high efficiency of its fuel pump is also the special advantage of the Mercedes-Benz airport fuelling truck. Above all in the refuelling of delayed aircraft its safe, rapid operation contributes appreciably to the maintenance of safety standards in air transport.

Water bowser type FLF 25
6-ton chassis · 115 h. p. diesel engine and all-wheel drive
520-gallon water tank · 52-gallon foam tank
Dry powder system
Rotating jet pipe on driver's cab

Fire-fighting truck type PLF 1500
3.5-ton chassis · 115 h.p. diesel engine
3,300 lbs. dry powder extinguisher,
particularly simple operation

Mercedes-Benz airport fuel truck
7-ton chassis · 145 h.p diesel engine
Capacity: 6,300 gallons aviation gasoline
520-gallon centrifugal pump
Extensive safety devices

MERCEDES-BENZ



The only aircraft ever to hold, at the same time, world records for height and for speed from point to point

* The ENGLISH ELECTRIC Canberra (powered by two Bristol Olympus engines) holds the world's height record for aircraft at 63,688 ft. (19.406 metres).

* The ENGLISH ELECTRIC Canberra (powered by two Rolls-Royce Avon engines) holds 12 world speed records, including London to Christchurch (New Zealand) at an all-in speed of 494.5 m.p.h. (795 k.p.h.).

'ENGLISH ELECTRIC' Canberra

THE ENGLISH ELECTRIC COMPANY LIMITED, QUEENS HOUSE KINGSWAY, LONDON, W.C.2

INTERAVIA

Deadline Notes

No. 7, 1955

PARIS AIR DISPLAYS

The 21st International Paris Aircraft Show at Le Bourget closed with flying displays of the latest French, British, Italian, Dutch, Belgian, American and Canadian aircraft on June 18th and 19th, 1955. Out of the total of 53 aircraft listed in the programme, roughly 20 were demonstrated to a broader public for the first time. - Interavia's August issue will contain a detailed review of the Paris Show.

GERMANY TO JOIN I.C.A.O.

The Ninth Session of the Assembly of the International Civil Aviation Organization, which closed on June 13th, accepted Germany's application for membership by 51 votes to 0, with one abstention. The application must now be forwarded to the United Nations General Assembly for approval. - During the session I.C.A.O. Secretary General Carl Ljungberg announced that Laos had adhered to the Convention on International Civil Aviation and will become the 66th Member State of I.C.A.O. on July 13th.

NO AUSTRIAN GOVERNMENT AIRLINE

The Austrian Cabinet has decided not to create a Government airline or to provide Government funds for the foundation of an airline.

N.A.T.O. AIR BASE LAARBRUCH

Laarbruch, Germany, base of the 2nd Allied Tactical Air Force, and considered to be the largest and most modern military airfield in Europe, is now completely operational.

R.C.A.F. REACHES AUTHORIZED STRENGTH

The Royal Canadian Air Force has now attained its authorized strength of 41 squadrons, according to a Defense Department announcement. Within a year, the number of fighter squadrons equipped with Avro CF-100 Canuck all-weather long-range interceptors has been increased from three to nine.

SEABOARD & WESTERN NOW SCHEDULED ATLANTIC COMPANY

Seaboard & Western, hitherto a non-scheduled freight carrier, has obtained a five-year certificate for scheduled Atlantic services (from New York, Philadelphia and Baltimore to Britain, Holland, Belgium, France, West Germany and Switzerland). - Seaboard thus becomes the third scheduled U.S. Atlantic airline, following Pan American World Airways and Trans World Airlines.

U.S. NAVY TO HIRE OUT CARGO AIRCRAFT

The Air Coordinating Committee, top Government aviation policy authority, has approved U.S. Navy plans for leasing some of its large cargo aircraft (initially four to eight Douglas DC-6A Liftmasters) to commercial operators, to "promote sound development of commercial air cargo operation and to stimulate the acquisition of newly-manufactured aircraft."

MEMORIAL FOR FREIHERR VON GABLENZ

On the occasion of the new Lufthansa's first commercial Atlantic flight, a memorial stone was unveiled for Karl August Freiherr von Gablenz, member of the Board of Directors of the old Deutsche Lufthansa, who was killed in an accident in 1942. The bronze plaque on the memorial bears the inscription: "The Lufthansa flying team, trained by him and inspired by his example, is indebted to him for high professional and human standards, as is the firm itself for its world-wide recognition."

* From INTERAVIA's world-wide news service, including INTERAVIA AIR LETTER, the daily international aviation news digest. — No part may be reproduced without written permission.

FRENCH NIGHT MAIL SERVICES

According to figures published by Air France's Metropolitan mail services division, regularity on the night mail services between Paris and the South of France reached 100% in 1954, with 5,980 night landings, 129 instrument landings, 5,007,117 kg of mail (roughly 715,000,000 letters).

K.L.M. ORDERS VISCOUNTS

K.L.M. Royal Dutch Airlines has placed its first substantial order for British aircraft, namely for nine Vickers Viscount 800 turboprop transports, to cost roughly £4,000,000 including spares. Deliveries are to begin in the summer of 1957. – Negotiations leading to the order began in mid-May 1955, when K.L.M. President I.A. Aler, accompanied by a number of leading K.L.M. officials, visited Vickers-Armstrongs' Weybridge works.

BRISTOL ACQUIRES S.N.E.C.M.A. JET DEFLECTOR LICENCE

The Bristol Aeroplane Company Ltd. has signed an agreement with Société Nationale d'Etude et de Construction de Moteurs d'Avions for manufacturing rights to the latter's thrust reversal designs and their application to Bristol's own engines. – Aerojet General Corp. acquired a similar licence for the United States a year ago.

LABORATORIES FOR ROCKET MOTOR AND ATOMIC RESEARCH

North American Aviation Inc.'s new laboratories for rocket motor and atomic research near Los Angeles, which are to be taken into use in mid-October, will employ a staff of 3,000 engineers, technicians and special workers.

*

WORKSHOP BRIEFS ...

Hispano Suiza's new H.S. R-800 axial-compressor turbojet delivers more than 2,420 lbs. static thrust (without reheat); dry weight 605 lbs. * RA.26 and RA.28 are new versions of the Avon axial-compressor turbojet. Both versions have a static thrust of 10,000 lbs. * Praga Doris B is the designation of a new Czechoslovak flat-six engine with a rated power of 200 h.p. at 2,900 r.p.m. * The French S.N.C.A. du Sud Est is negotiating with Republic Aviation Corp. for the latter to build the SE.210 Caravelle twin jet medium-stage transport under licence in the United States. * The SIPA 1000 Coccinelle light two-seat sports aircraft has begun flight testing under SIPA Chief Pilot Roger Launey. * A Chance Vought XF8U-1 prototype is undergoing flight tests at Edwards Air Force Base, California. This swept-wing Navy fighter is fitted with a Pratt & Whitney J-57 turbojet and is said to be capable of speeds of 850 to 900 m.p.h. – Heron Executive Special is the name of a luxury version of the D.H. Heron 2 with cabin accommodation for six persons. * The first of three pre-production models of the S.N.C.A. du Sud Est Baroudeur has been completed. First flight of this aircraft – designation SE.5003 – in August 1955. * A two-seat trainer version of the Saab Lansen is to be built by Svenska Aeroplan A.B. in Linköping. * Two jet deflection systems have been developed in the United States by Goodyear Aircraft. * Flettner Aircraft Corp. is working on projects for large helicopters. * Fourteen different models of pneumatic engine starters are being built by Hamilton Standard (United Aircraft Corp.) and are used in sixteen different fighters, bombers and transport aircraft. Power between 40 and 150 h.p.; weight between 20 and 30 lbs.; average dimensions 10.5 x 8 ins. * The prototype of the Handley Page Herald is in final assembly; first flight is planned for August 1955. * Aerobrake Thrust Reverser is the name under which S.N.E.C.M.A.'s jet deflector is known in the United States (licence production by Aerojet General Corp.).

* * *

Space Ships, Satellites...

There is no doubt about it, space travel enthusiasts have set their sights high . . . Yet some day space travel will become a reality.

When it does become technically feasible, new problems will arise, such as that of transport from one solar system to another. At "normal speeds"—only a fraction of the speed of light—such operations would take many times longer than a human life span. Hence if such space voyages are to be made, either several generations would have to be born in the space ship, or the latter would itself have to travel at a speed approaching that of light. In the former case the simple space ship would have to be replaced by a complete small planet, biologically and energetically self-sustained. The round trip to Pluto would take the small matter of 92 years... as the distance between our sun and its most distant planet is 3,671,000,000 miles.

Jules Verne? By no means, *navigare necesse est,* space travel will also come.

In May 1955 a rocket conference was held in Düsseldorf, Germany, to which the prelude and certain justified criticism in the German press testified to some confused thinking. In the period after 1945, when aviation was a forbidden word for Germans, some of the more persistent spirits turned their thoughts to the future and space travel. Engineers and dreamers got together in research and discussion. At the Düsseldorf meeting they made the mistake of confusing future space travel aims with concrete results. One speaker, standing beside an anti-aircraft rocket, discussed what contribution Germany might one day make to space travel, mixing research with business, means of transport with weapons of war. Professor Karl Schütte, Chairman of the German Space Research Association, his entourage and even official circles in the host province of North Rhine-Westphalia dissociated themselves.

To indicate the clear division between rocketry and space travel planning *Interavia* has now prepared a space travel issue, as a supplement to the May 1955 rocket issue.

Space travel is no longer merely a dream. Former Air Force Secretary and now Senator Stuart Symington, still one of the foremost U.S. air power proponents, several years ago called for the creation of an artificial satellite. The Pentagon has never given up these plans, and sooner or later they will be realized, probably not only in the United States but also in the Soviet Union.

How such a satellite will be built and what it will look like is described by a leading expert. And how man may later venture further out into space is outlined by a German-American engineer who once worked at Peenemünde and today belongs to the guided missile division of one of the United States' major aircraft manufacturers. Finally, for the educated layman an article on Walt Disney's latest documentary film "Man in Space" is also included.

*

All this already falls under the heading "aviation" in its wider sense and thus in *Interavia*'s province. *EEH*

Space Flight is Possible *(But Who'll Pay for It?)*

BY SCHOLER BANGS, LOS ANGELES

Walt Disney may be America's "Secret Weapon" for the conquest of space!

Apparently, and quite by accident, he has discovered the "trigger" that may blast loose his country's financial resources and place the Stars and Stripes of the United States aboard the first inhabited earth satellite and the first space ship to encircle the moon as a trial run for an era of interplanetary exploration.

Scientists concede that human space flight is theoretically possible. And, generally, it is assumed that Russia and the United States are the two nations best equipped with resources and competitive urge to prepare the undertaking.

No one, however, seems to have come up with any clear answer to the No. 1 question confronting space planners:

"Who'll pay for it?"

In terms of the capitalist nation, the figure of $10,000,000,000 appears recurrently as a nice, round sum for getting space travel off to a good start.

One might imagine the amount, or its Soviet equivalent, as being relatively incidental to the overall space flight program, considering the stature of the nations involved.

In fact, U.S. space proponents figured they had made it as the "cold war" between the two world powers showed signs of becoming a "military ice age." They gazed upon the military as a prime source of dollars-without-end, and hopefully suggested that the first nation in the sky with an observation-post satellite would dominate the other. The more politically astute even added that such dominance could prevent a "hot war," and even assure lasting "world peace."

Walt Disney and his scientific consultants on "space travel": from left to right: Dr. Wernher von Braun, rocket designer; Willy Ley, rocketry and space flight historian; Walt Disney; and Dr. Heinz Haber, space medicine authority.

The only thing wrong with this military approach is that it doesn't work!

It is true that under military pressure both the United States and Russia are spending some effort and money on space flight research. But neither nation's armed forces may be expected to sponsor an all-out multi-billion-dollar do-it-now satellite project which might intrude heavily upon immediately available weapons.

In the case of the United States, the U.S. Air Force could hardly go to the Congress and say, "We do not yet have a production missile for intercontinental retaliation, but in the meantime how about letting us have an extra ten billion to build a space ship?" And imagine the horrified reaction of a Congressman: "What would my constituents do to me at the next election if I were to vote for a comic-strip space patrol!"

Into this atmosphere has come Walt Disney, Hollywood's past master of the motion picture documentary film, creator of countless wartime training films, of "Seal Island", "Beaver Valley", "The Living Desert," "The Reluctant Dragon", to bathe the U.S. space horizon with a dazzling prospect. He has now produced a motion picture which he has titled "Man In Space".

It has never had "TOP SECRET" branded upon it to suggest awesome military importance, because it is simply an entertainment film.

In Hollywood, space fantasies are dime-a dozen for the television trade, and as preposterously improbable as they are numerous. But Disney has chosen to present merely a research-factual review of man's itch to explore the unknown; estimates of the flight equipment needed to probe the space wilderness, and a "best guess" of the problems and sensations which will be encountered by the first human to inhabit a space vehicle.

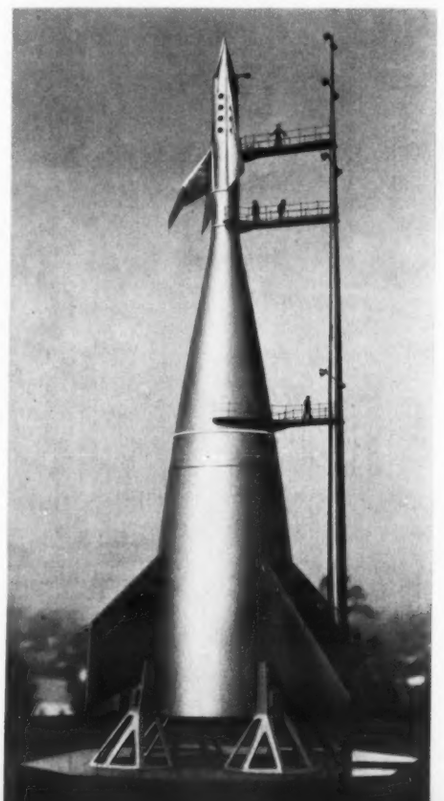
To do this he has brought together, for the first time in a motion picture, three internationally noted experts of space research: Willy Ley, the rocketry and space flight historian; Dr. Wernher von Braun, the German rocket designer, now engaged in missiles projects at Redstone Arsenal, Alabama; and Dr. Heinz Haber, the space medicine authority and associate physicist in the Department of Engineering at University of California, Los Angeles.

Ley brings up to date the advances man has made toward the barriers of space. Dr. von Braun presents his estimates for an immediately practical earth orbit space rocket, and offers in logical steps its construction, the training of its space crew, and the man's first blast-off into the void beyond Earth's atmosphere. And Dr. Haber introduces an appealing, thoroughly Disneyesque cartoon personality, *Homo Sapiens*

Disney' four-stage space rocket "project" as shown in his film, "Man in Space". The passenger-carrying fourth stage (top) has wings which should enable it to return to the earth.

Extraterrestrialis, self-conscious, shyly serious, delighted and bewildered by his role of the first human to be subjected to a rocketing space flight. What happens to H.S.E. is exciting and alarming as he does everything wrong in the state of apparent weightlessness, and is subjected to a barrage of meteorites and cosmic rays. Of course, being the hero of the show, Mr. E. survives it all quite handily,

The Disney Studios built a model of the four-stage interplanetary rocket.



presumably ready for a go at Mars on the next trip out.

Disney's immediate achievement, with the aid of this triumvirate of space authorities, is the suggestion that space travel no longer is a wild dream; that it is so near that we can practically feel the earth tremble under the rocket blast of Dr. von Braun's space ship.

"Man In Space" is believable, and Mr. Disney has close to one hundred million Americans believing. It was first shown on a network of 160 television stations in March and repeated on June 15th. A third showing is to come on September 7th, and if no production snags are encountered the Disney audience will be treated to a new space adventure, a rocket trip around the moon.

By then about half of the voting population of the U.S.A. probably will have reached two impressive conclusions: "It CAN be done!", and "Let's get on with it!".

U.S. space partisans are well aware of the potential of a nation of "believers." The scientists who participated in the filming of the Disney show are certain that through public enthusiasm financial support of a space project will become readily available. Dr. Haber told me: "We are in agreement that the 'How soon?' of space exploration is largely a political question, and that the hesitation of political agencies to assure funds for the project will disappear as popular support makes itself felt.

"However, one should not be misled into anticipating that if the Congress should vote unlimited funds tomorrow we could begin immediate construction of a space vehicle.

"We could reduce by years, perhaps, the target date for man's first space flight; but none of us have any illusions concerning the vast amount of preliminary work still to be done. We merely are more hopeful now, and convinced that we are on the right approach.

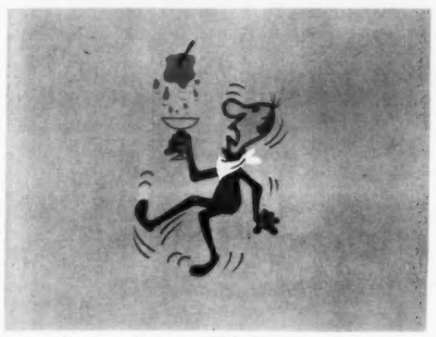
"I think it quite possible that I will live to see its achievement."

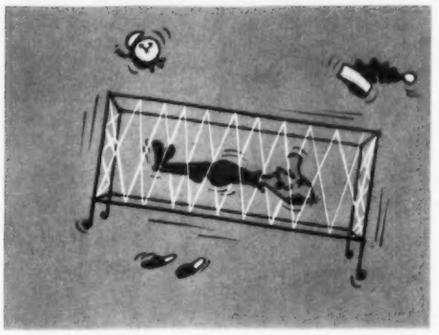
Dr. Haber believes that both Dr. von Braun and Willy Ley are in agreement with him that, before construction of a manned space vehicle can be attempted, exhaustive research data must be gleaned from tests of intercontinental ballistic missiles and, a step beyond, un-manned but highly instrumented earth satellites.

"Then," he said, "we will be ready to tackle the cross-country rocket plane which Dr. von Braun* envisions."

"These are practical steps toward the realization of unlimited space travel, and they

* and others: cf. *Interavia* No. 5, 1955: "The Rocket-Driven Commercial Airliner", by Dr. Walter R. Dornberger.





Among the new characters Walt Disney created for his film "Man in Space" is *Homo Sapiens Extraterrestrialis*, the Mr. Average Man who encounters difficulties and adventures in adjusting to interplanetary rocket travel. The three drawings illustrate the predicaments of weightlessness. The Dry Martini, complete with olive, floats to the ceiling. Which way is up or down, or even here or there? Homo Sapiens floats asleep inside an empty bedstead – no mattress is required.

should not be too slow in their development. The manned station in space is quite another matter, however, and it is my strong belief that we have not yet reached the point of specific planning of the undertaking. We do not yet have answers to some of the major problems, both political and scientific. The mustering of scientific manpower for such a project presents, in itself, a major obstacle."

Such are the views of one who for many years has been in the foreground in United States discussions of space pioneering. In view of his careful, scientific recognition of many other stumbling blocks and barriers on the space highway it might appear strange that he should find himself involved in a television space show aimed solely at the entertainment of a mass audience principally concerned with meeting the monthly payments on their 1955 automobiles.

What persuaded him to join the Disney venture?

Dr. Haber relates the incident as follows: —

"I was surprised when I received a call from the Disney studio in April of 1954. They explained that they were putting together a series of television films, and would like to have my participation as a consultant on a 'science-factual' story about space travel. I was dubious because I knew from past experience that in Hollywood pictures and science don't mix.

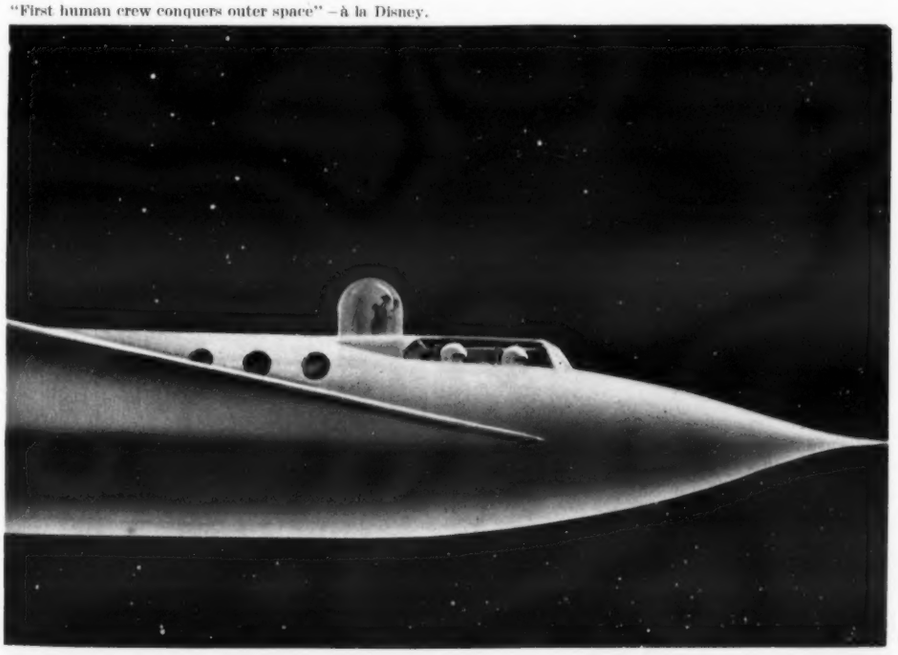
"The studio had pinned upon the four walls of a large room otherwise occupied only by comfortable chairs with wheels on their legs a massive array of rough sketches depicting the plot and sequences of the space story. As we wheeled ourselves past this display, I was asked my reaction to every sketch.

"The story line was quite different than I had expected. Normally when a Hollywood studio does a space picture, scientific facts are badly twisted and distorted to fit a more or less silly plot of fiction. The projected Disney show had no plot—or rather, its plot was science and science's potential future. True, there were a number of sketches on the wall displaying material that was controversial, invalid or scientifically doubtful. We scientists were put to work to weed out these flaws.

"It was very gratifying to find out that the science consultants to the Disney show were allowed to be true consultants. Their advice and suggestions were taken at face value. At one time Disney had told the artists 'If our scientists find it necessary to kill a good gag because it violates a law of nature—it is just too bad. Then we will have to find new gags that are consistent with scientific facts'".

The space rocket leaves its hangar in preparation for launching.

"First human crew conquers outer space" – à la Disney.

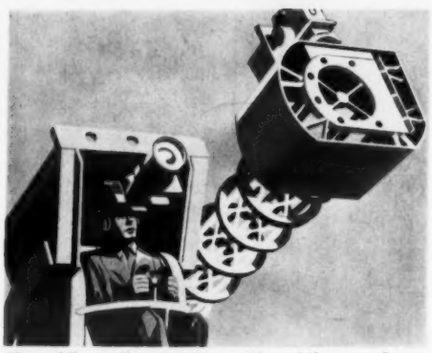


Dr. Haber feels that for himself and his consulting associates the making of the Disney film has brought about a new appreciation of the art of making pure science understandable to the unscientific lay mind.

"In putting together the space story the Disney artists became scientists, and we became Disney artists, inventing jokes and gags to convert pure science into pure entertainment and still present scientific facts which are important to an understanding of space problems.

"When we sought to personalize probable human experiences in space flight, the little

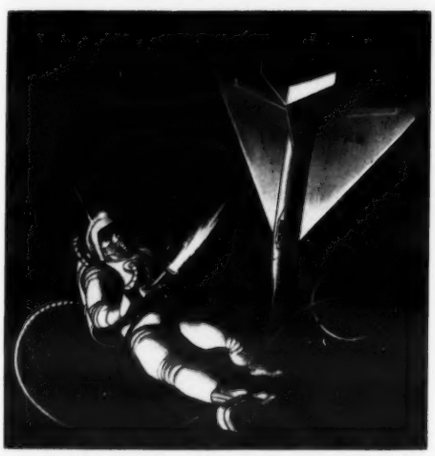
In full space flight a member of the crew takes aerial photographs – of what?



Meanwhile, on the ground a member of the ground crew radar-checks the course of the first space rocket.

cartoon character seen in the television show evolved. This droll little person did not come into being easily, however. The Disney artists drew more than a score of caricatures of the 'first man in space' before the lucky fellow was selected. We chose to name him *Homo Sapiens Extraterrestrialis* not only to identify him with scientific clarity but, as well, to satisfy his obvious vanity at being selected for the important role.

"He became so real to us that very soon we found ourselves actually talking to him as a living actor: 'No, Homo, not that way! you're weightless; just floating in space. Show surprise when the Martini you're raising to your lips leaves the glass and keeps on going to splash against the cabin ceiling.' We constantly asked each other, 'How will Homo react?' when we placed him in one embarrassing predicament ofter another."



A crewman from the interplanetary rocket leaves his vehicle for exploration and moves himself through outer space by a portable rocket propulsion unit.

In the Disney show, *Homo Sapiens* is subjected alternately to the crushing forces of acceleration and the bewildering effects of weightlessness. He is machine-gunned by bullets of cosmic rays; sucked by explosive decompression through a hole punched in the cabin by a wayward meteorite; seared on one side and frozen on the other when exposed, outside the space ship, to solar radiation; alternately delighted and terrified by the thrust effects of his small jet pistol as he tries to regain the security of his space vehicle. Repeatedly, never quite able to grasp the consequences of his actions, he is subjected to the gross indignities of weightlessness in 'free fall' through space.

Quite understandably *Homo's* misadventures in the weightless state command major prominence in the picture. It falls into the category of "major problems" of the space planners.

"Actually, while we have had and will have ample opportunity to test on the ground the structures, powerplants and physical accessories of our space ships, there has been very little opportunity to learn from actual experience just how a human will react to the weightless state," Dr. Haber says.

"We can duplicate the effects of acceleration with the human centrifuge. Quite readily we can test human tolerances of heat and cold. We know what to expect of inanimate objects in the state of weightless suspension. But we know very, very little about human reactions in this field.

"As of today, our only tool for experimenting with human weightlessness is the fast-flying airplane, directed upward at high speed and then held as long as possible to the arc of a parabolic path. With equipment so far available, we have been able to maintain a crude approximation of the weightiess state for as long as thirty-five seconds.

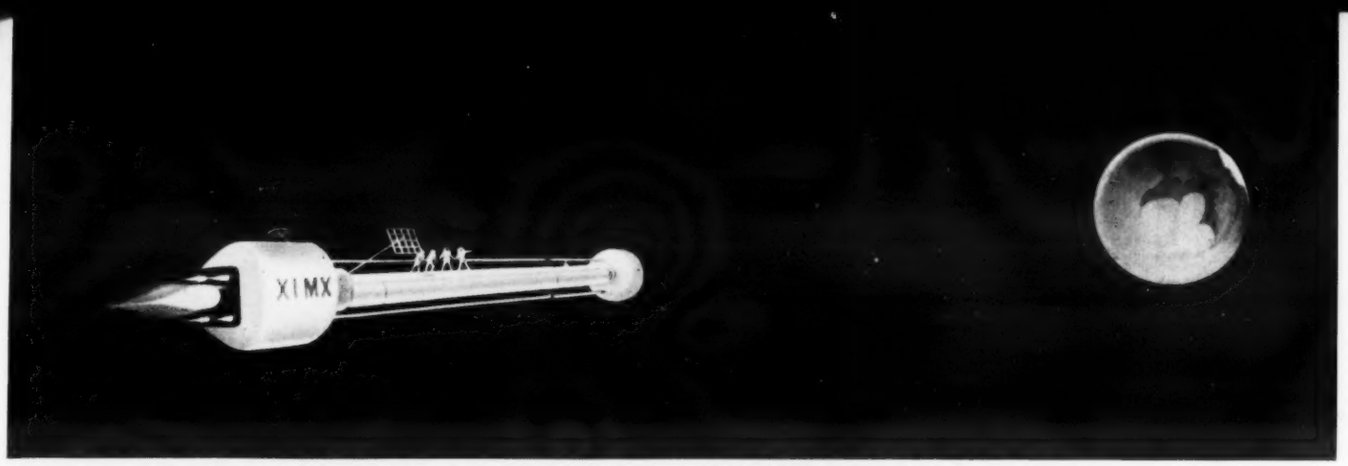
"I, for one, am not too happy with the results.

"When Major Charles Yeager, the first man to fly faster than sound, experimented with weightlessness in a jet fighter, he reported that after eight seconds in the parabola he became completely disoriented and had to break away from the curve. He said, 'I felt completely lost in space—as if I were sitting on a big ball and being rotated slowly'.

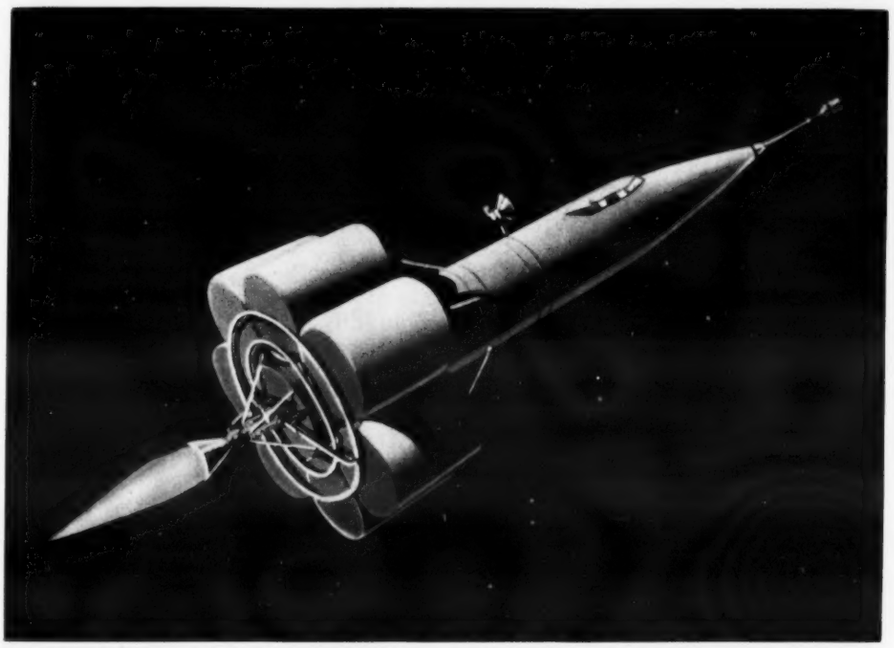
"Others who have attempted it have come down with quite contradictory reports of having experienced no disturbance.

This is a "space wheel", an artificial satellite, stationed 1,075 miles beyond the earth. It will serve as an "observation post and space station for interplanetary travel when man finally conquers outer space", says the Disney Studio title. In foreground on the "wheel" are men working inside their "space bottles".

This is a "space bottle" as featured in Walt Disney's film. It is designed to permit personnel to work in outer space on the construction and maintenance of man-made satellites. It contains rocket motors in the top and bottom. Seven arms, located around the circumference, are fitted with specific tools required for construction of satellites in outer space.

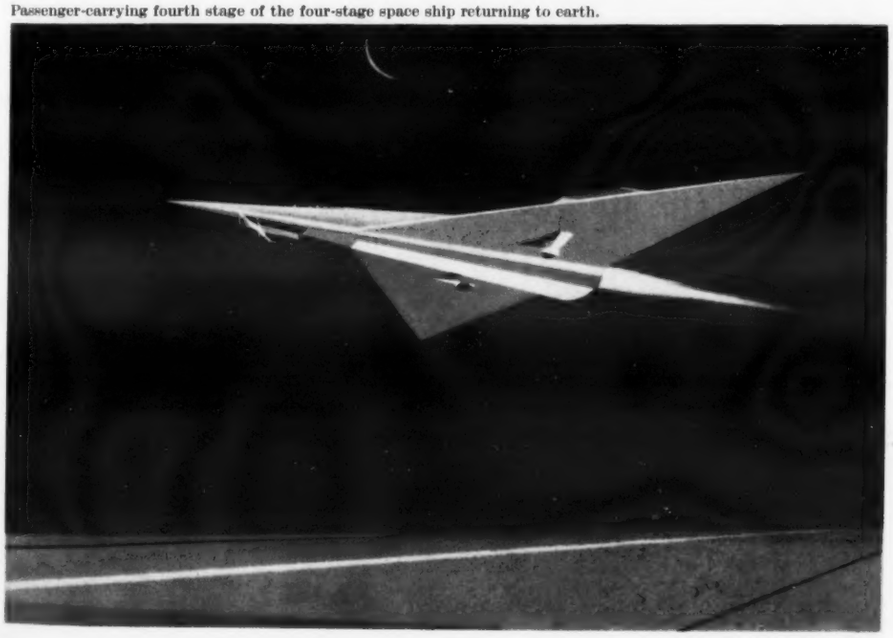


From the "space wheel", other ships will move on to distant planets. This one is heading for Mars. The ship has been "designed" by Willy Ley.



This is a model of Dr. von Braun's "moon rocket ship", to be built in space at a man-made satellite. At its rear it carries cargo and fuel.

Passenger-carrying fourth stage of the four-stage space ship returning to earth.



"I cannot help but conclude that Chuck Yeager, an exceptionally good pilot, may have been the only one to maintain a steadily constant parabolic flight path, and it is wholly possible that we will get no really informative data on the physiology of weightlessness until we can so instrument a plane that it will maintain its parabola automatically."

However, Dr. Haber believes that the chief concern of 'zero gravity' researchers will be that of discovering how to acclimatize space crews to their unusual situation. He says he believes that humans can adjust to the sense of weightlessness and through experience learn how to live with the phenomenon. He adds:

"Even should the transcontinental rocket plane develop before we have all the answers to weightlessness, we probably will not have too many worries. Assuming that the rocket plane reaches a speed of three miles per second in outer space, its passengers should not be exposed to weightlessness for a period greater than six minutes. Exposure of this length should not present any serious problems of human tolerance."

Small animals exposed to relatively lengthy periods of weightlessness in U.S. high altitude missile flights have shown no serious disturbance beyond disorientation, which evidently was modified when they were provided supports to which they could cling. At the point of rocket burnout, and start of the weightless state, test animals stopped breathing for the time of five or six exhalations but then resumed breathing normally.

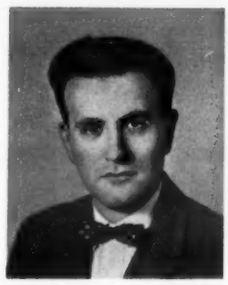
While such experimental details are either absent or only lightly touched in the Disney picture, Dr. Haber and his fellow scientists appear to be convinced that the basic story of man's drive to learn what is beyond his earth's atmosphere has been well told, and effectively.

Walt Disney will probably expand the story in ensuing pictures. Those who know him are certain that he will not be swayed in the least by being considered America's "Secret Weapon" of space conquest.

The "Mouse" Project

BY PROFESSOR S.F. SINGER, UNIVERSITY OF MARYLAND

Associate Professor of Physics at the University of Maryland since 1953, the author has carried out extensive research into the origin of high altitude radiation and the physical properties of the upper air layers. For this purpose he has used small experimental rockets for short period measurements, but has also worked out plans for a miniature unmanned earth satellite for measurements over longer periods. His "artificial moon", measuring only 30 cm in diameter, which bears the intriguing name "Mouse" (an abbreviation of Minimum Orbital Unmanned Satellite, Earth), is designed to obtain further information on ultra-violet and X-radiation from the sun. — Professor Singer is a member of the United States' Physics Society, Rocket Society and Geophysical Union, Britain's Royal Astronautical Society and Interplanetary Society, and the Washington Academy of Sciences. He also belongs to the Ionosphere Commission of the U.S. National Committee of the International Scientific Radio Union (U.R.S.I.) and from 1950-53 was Scientific Liaison Officer with the Office of Naval Research, U.S. Embassy, London.



Space flight today finds itself at nearly the same point as aviation fifty years ago, but with two important differences. There was no science of aviation, no aerodynamics, when the first airships took wing; there exists today a completely worked out theory covering all the various aspects of space flight. The other important difference has to do with the tremendous rise within the last fifty years in the sciences of radio, electronics, instrumentation and control.

Whereas airplanes had to be manned in order to fly, space flight will certainly start with vehicles which are flown and controlled by instruments.

There are, on the other hand, also important similarities; aviation was started by enthusiasts, by people without large means and support, with small motors and flimsy machines. If they had insisted on development of large aircraft engines before starting their experiments, aviation would never have come about because there existed no incentive for developing these engines. Similarly, for lack of direct motivation, and because of their great expense, large rocket motors will probably not be developed *in the immediate future*.

Instead, the approach to space flight will have to be made with available rocket motors and other developed components; these can then be put together into a multistep rocket vehicle. This appears to be the only method feasible at present for giving a small body the high velocities necessary for a satellite orbit or for escape. Even so, the limits set by present developments in large rocket motors allow us to place only extremely small payloads, of the order of 20 kilograms, at altitudes just barely beyond the effects of the atmosphere (at about 300 kilometers) where the atmospheric drag may be low enough to allow the vehicle to survive for some days or weeks. To place a satellite at a much higher altitude would decrease the present small payload even more and in order to send it into an escape trajectory out of the earth's gravitational field we would have to reduce the payload to a minute value.

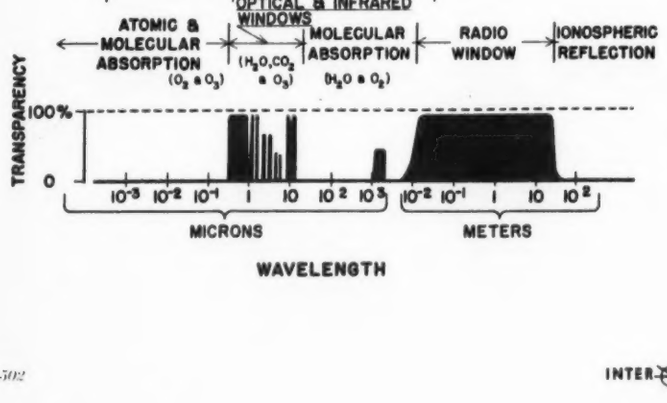
Apparently we have reached a disappointing impasse; it seems very unlikely that more propulsion will be forthcoming soon which would raise the payload and altitude performance. On the other hand, what can be done with existing techniques seems disappointingly small and trifling unless we can demonstrate the usefulness of a 20 kilogram satellite orbiting the earth at about 300 kilometers. A demonstration of the worthwhileness of such a project would provide a motivation for its construction. For only by starting with a minimum satellite *which is both feasible and worthwhile* can we hope to advance into space flight.

Even with the present limitations of weight and altitude a *properly instrumented* satellite could provide us with a vast amount of important information about outer space and extra-terrestrial radiations, particularly from the sun, and about the earth and its atmosphere. One can view such a satellite as an extension of present high altitude rockets which are being used to explore the upper atmosphere. During the past eight years, over two hundred of these rockets have been launched at the White Sands Proving Grounds in New Mexico, U.S.A., from ships at various positions in the Pacific and Atlantic Oceans, and even from balloons in the Arctic regions. They ranged from the huge V-2 down to very small rockets weighing only 100 kg. One small rocket which was launched from the nose of a V-2 at the end of its burning period reached the peak altitude of 400 km above sea-level, the highest ever attained by a man-made object.

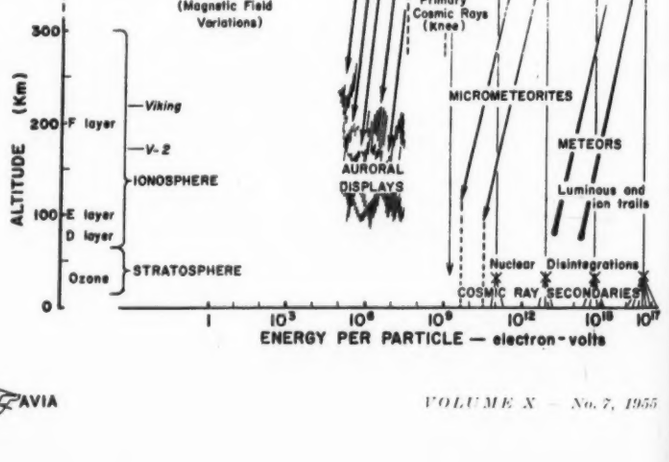
*

A number of basic questions must now be answered: What is the purpose of the rocket

Transparency of earth's atmosphere for electromagnetic radiation as a function of wavelength in microns or metres. The two "windows" for light and infra-red rays on the one hand, and for ultra-short radio waves on the other are clearly discernible.



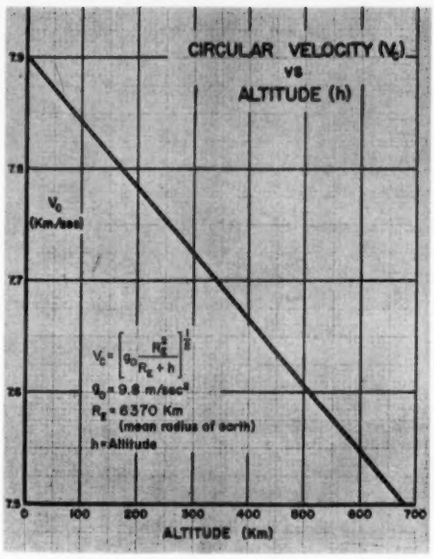
Penetration of particles into the atmosphere, showing depth of penetration (in km) as a function of energy per particle in electron-volts (1 erg = 6.29 × 10¹¹ electron-volts).



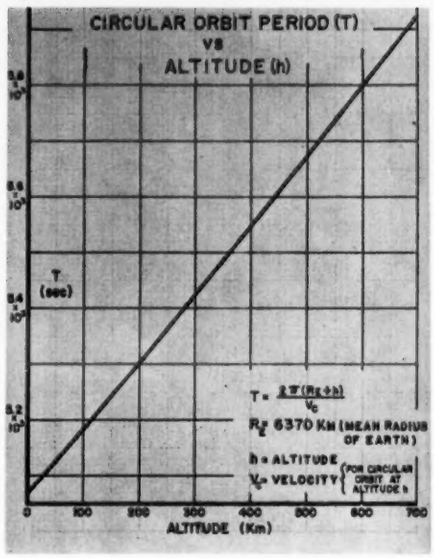
or satellite observations? How are the observations performed? What results are obtained and how are they applied? Are they of practical importance?

The basic reason for rocket experiments comes about because the atmosphere, in spite of the fact that we can see through it, is transparent only for the visible radiation (i. e. for electromagnetic radiation with a wave length of 7,700 to 4,000 Ångström — Ed.) and for certain radio waves. The atmosphere is not transparent, for example, to the ultraviolet radiations and X-radiation coming from the sun. It is also well known that the ionospheric layers in the upper atmosphere will not transmit radio waves but will bounce them back. All particle radiations (e. g. protons, atomic nuclei etc.) coming from outer space are either completely stopped, or modified in character. Therefore, in order to study the radiations which are not transmitted *through* the atmosphere one has to go above it and carry out measurements at very high altitudes. Such studies have been done in a variety of ways and we know quite a bit by now about primary cosmic ray particles and about the emission of ultraviolet radiation from the sun. This latter knowledge is very important; it not only reveals much about the various mechanisms which operate on the sun's surface and in the sun's hot atmosphere, but these radiations also have a very profound influence on our own atmosphere. For example, they produce the ionospheric layers already referred to which are so important for radio communication. Although most of the heat energy which we receive from the sun arrives in the visible range of the spectrum, the ultraviolet is important because it produces gases such as ozone in the upper atmosphere which tend to trap this heat near the earth somewhat in the same fashion as a greenhouse. We suspect, therefore, that the ultraviolet emission from the sun may have considerable influence on our weather.

We know further that although the sun appears to be a stable type of star, it is actually quite variable when it comes to emitting ultraviolet and X-radiation. We believe that its output of ultraviolet radiation may change by factors of the order of 1,000 when the sun's atmosphere really becomes disturbed. Naturally, we would like to know more about these disturbing conditions. Here, however, appears the most important handicap of present-day rockets. It is true they can go to very high altitudes and therefore look at the sun directly and measure all of its radiations. However, they cannot stay up very much longer than perhaps 3 to 6 minutes. And one would like to observe the sun for a period of perhaps several weeks in order to learn something about these solar disturbances. It is for this reason that astrophysicists, particularly those interested in solar physics, have become very much concerned with the possibility of building a vehicle which will stay above the atmosphere for long periods of time.



Circular velocity V_c for earth satellites (in km/sec.) plotted against distance of orbit from earth's surface (altitude, in km).

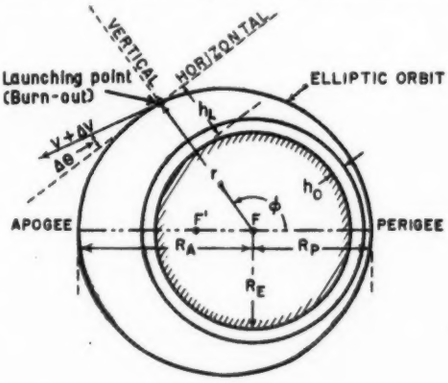


Circular orbit period T of earth satellites (in thousands of seconds) as a function of distance of orbit from earth's surface (altitude, in km).

From this discussion it appears that the requirements which a minimum instrumented satellite has to satisfy in order to be useful are very modest, merely to remain above the appreciable atmosphere, say 100 kilometers, for periods of days or even hours. The satellite is of course unmanned, but it is not even necessary to recover it physically in order to make it useful. All the information picked up by instruments in the satellite can be broadcast to ground receivers by radio telemetering techniques. The satellite would not even have to be visible; its position could be determined to good enough accuracy by radar techniques. It is clear also that the actual details of the orbit are of little consequence to the usefulness of this satellite. Even variations in altitude will not affect its essential value and it may therefore be allowed to depart from a circular orbit into an elliptical one. This fact alone allows the removal of the most difficult control problems and makes it possible to talk about the project in a practical way.

Let us now consider what would be involved in building the smallest possible useful earth satellite. A proposal for such a satellite has been made recently by the author and has been christened the MOUSE (Minimum Orbital Unmanned Satellite, Earth). It would consist of a spherical or cylindrical shell, about 30 cm in diameter, carrying a payload of about 20 kg of scientific equipment. In fact, we would instrument it with Geiger counters to measure the intensity of the cosmic radiation and with photon and X-ray counters to measure the intensities in the solar ultraviolet and X-ray spectrum. This satellite circling the earth once every 90 minutes at an altitude of 300 km would keep us in touch with events on the sun and would allow us to link up these ordinarily inaccessible solar data with solar observations from the ground. This in turn would allow us to form a consistent theory of solar processes and perhaps make possible prediction of the solar effects which have such tremendous practical importance for radio communication and meteorology. It seems decidedly worthwhile therefore to tackle the difficult technical problems which will lead us to the final achievement of this research satellite.

Elliptical orbit of an earth satellite, caused by exceeding the circular velocity by ΔV and launching angle zero by $\Delta\Theta$ at burnout altitude h_L. The foci of the ellipse are marked F' and F.



R_E = MEAN RADIUS OF EARTH
R_P = PERIGEE DISTANCE
R_A = APOGEE DISTANCE
h_L = ALTITUDE OF BURNOUT
h_0 = CRITICAL DRAG ALTITUDE

EQUATIONS OF ORBIT

$$r = \frac{a(1-\varepsilon^2)}{1+\varepsilon\cos\varnothing} \qquad \varepsilon = \frac{R_A - R_P}{R_A + R_P} \qquad a = \frac{R_P + R_P}{2}$$

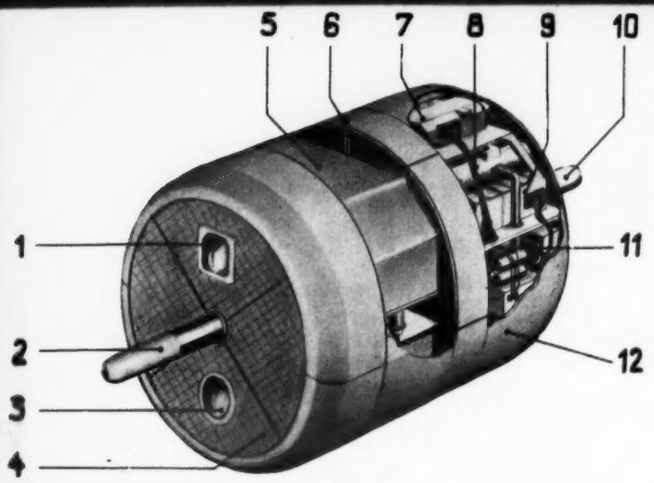
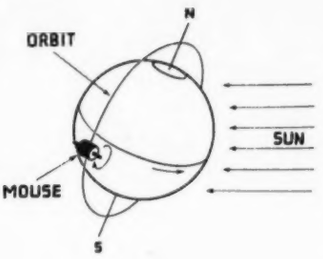


Diagram of a "Mouse" miniature unmanned satellite: 1 – solar ultra-violet detector; 2 – aerial housing on side towards sun with counters for electrons and heavy particles; 3 – solar X-ray detector; 4 – solar energy transistor battery; 5 – power supply; 6 – telemetering storage hoop; 7 – earth's albedo detector; 8 – collector for cosmic dust; 9 – magnetometer; 10 – aerial housing on shade side with counters for cosmic rays and aurora particles; 11 – ultra-shortwave telemetering transmitter; 12 – radar beacon.



A carefully chosen circular orbit crossing both poles of the earth, with its plane at right angles to the sun-earth line, would enable the dwarf satellite always to "see" the sun. The satellite can be stabilized in space by rotation about its transverse axis (like a gyroscope).

The many problems connected with the MOUSE satellite have now been investigated more closely in a theoretical manner. For example, it turns out that reasonable life times of the order of days or weeks above the atmosphere are possible with only rudimentary control of the final angle of launching and with no necessity to control the final burn-out velocity. The orientation of the satellite in space can be predetermined and controlled automatically by using the gyroscopic principle. By choosing the proper orbit, namely the one which goes across both poles of the earth, and by placing the satellite orbit in a plane perpendicular to the sun—earth line, the satellite can be made to view the sun at all times. This fact not only allows it to make continuous solar observations but, thanks to the development of the solar transistor battery, will enable it to obtain sufficient electric power for its radio transmissions.

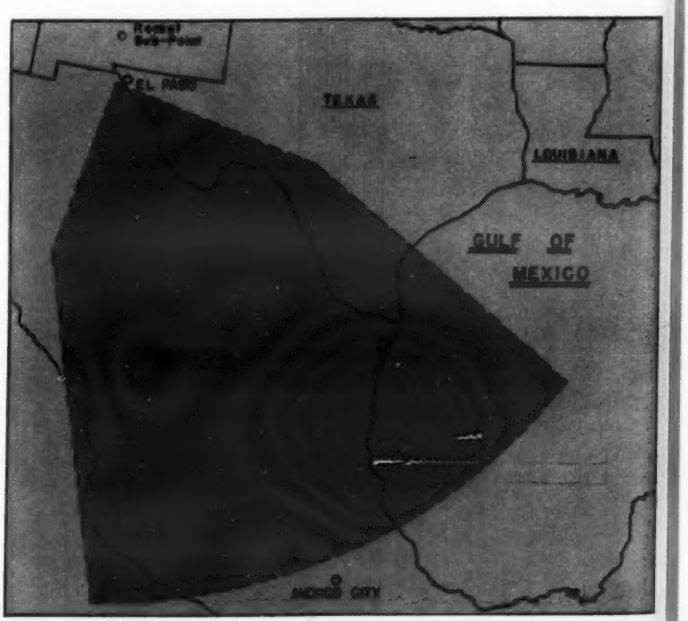
Some of the more fascinating research applications of the satellite, in addition to the study of the all important solar radiations referred to, will be investigations about the origin of the cosmic radiation, the nature and distribution of micrometeorites and cosmic dust, investigation of the causes of the polar aurora, studies of the properties of the outer fringes of the earth's atmosphere, and studies of the earth's albedo (sunlight reflected back into space by clouds) which may allow forecasts of long term climatic changes. A small increase in the earth's albedo due to increased cloud coverage would lead to an appreciable lowering of the average temperature of the earth's surface. The MOUSE satellite, by measuring the reflected sunlight on a continuous and world-wide basis, would allow us to make these economically important estimates. Another interesting experiment calls for the emission of sodium vapor from the satellite into the earth's upper atmosphere. Once emitted, the sodium would glow with its characteristic yellow light. Minute quantities suffice to lay down what amounts to a continuous sodium trail whose motion and dispersion can be observed from the earth.

There probably exist many other useful aspects of this minimum satellite, but the above examples may suffice. There appear to be no major obstacles at the present time to the launching of this minimum satellite, certainly not on the technical side. Even the cost picture is a very reasonable one, remembering that we are now spending of the order of 100,000 dollars per minute for high altitude data in our most advanced types of upper atmosphere research rockets. A minimum satellite would provide many days of observations which could not otherwise be made and could be built for less than the cost of a medium sized modern bomber.

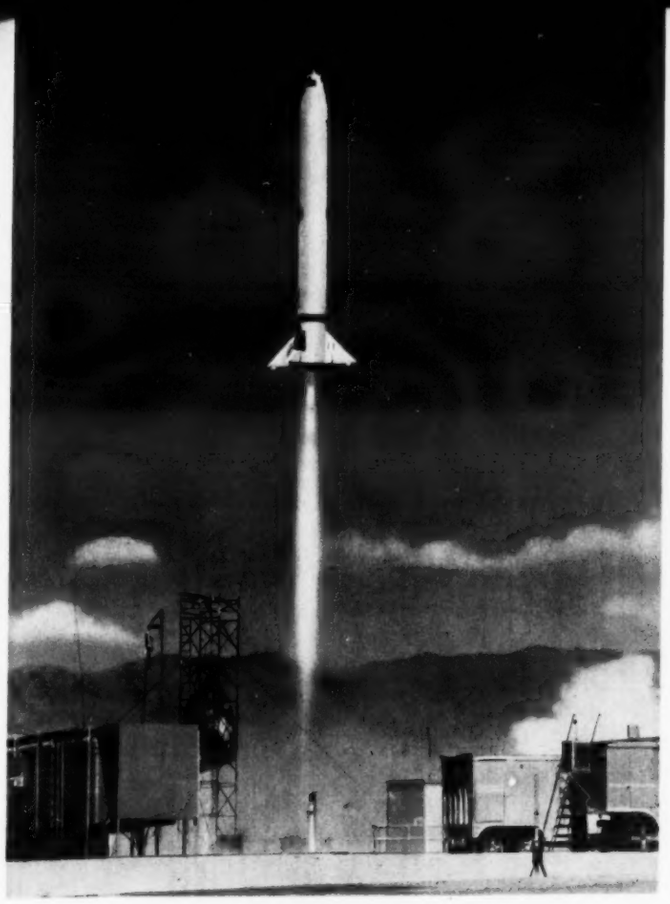
The arguments favoring such a satellite are so compelling that its establishment seems almost inevitable within the next five to ten years, assuming that no other important activities develop. It is interesting to speculate whether the impetus of this first satellite will eventually lead to the development of larger rocket motors and other techniques which would be needed to produce larger and more ambitious satellites carrying television cameras and telescopes; satellites which are manned; and finally, space ships. I am willing to predict with confidence all of these developments during this century. We need only remember how utterly impossible and improbable supersonic flight and vertical take-off appeared 50 years ago.

On top of the World

A record-breaking single-stage rocket climb to an altitude of 158 miles —about 835,000 feet—was accomplished by a *Viking 11* research vehicle of the U.S. Navy fired from the White Sands Proving Ground, New Mexico, on May 24th, 1954. Aerial cameras installed in the nose took a series of pictures which are the highest photographs ever taken of the



Shaded part shows area covered by composite photograph.



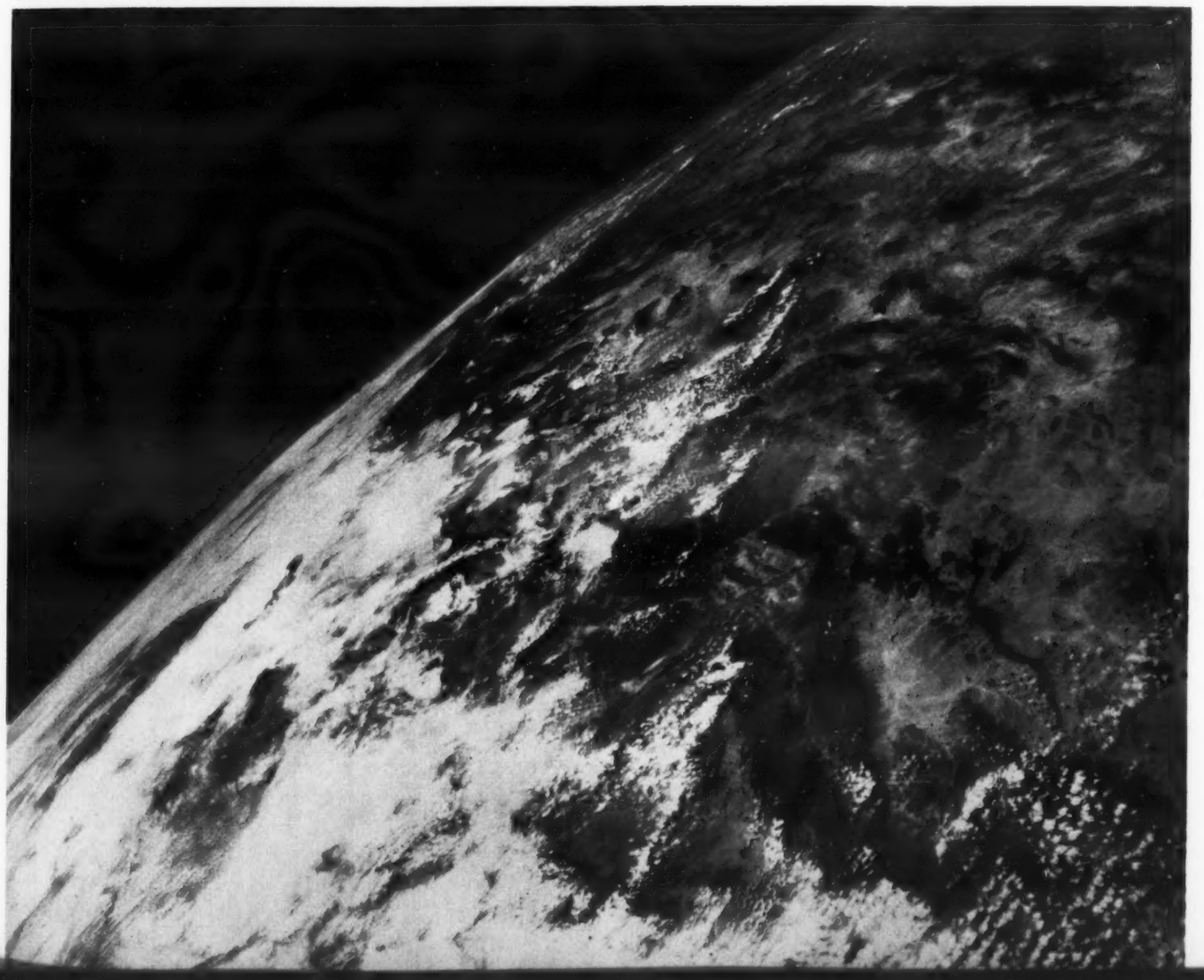
Viking 11 takes off on its record-breaking flight.

earth, and they are unusual for their clarity and detail. These photographs were released only recently by the U.S. Defense Department.

The main picture on this page, a composite photo consisting of three images taken at intervals of a few seconds at more than 140 miles above sea level, covers approximately 600,000 square miles of Mexico and Texas. From the camera to the horizon is about 1,100 miles, and the section of the horizon spans about the same distance. The camera is looking south-southeast from the vicinity of El Paso, Texas. Mexico City is just on the horizon about the middle of the photograph. The Gulf of Mexico is on the left-hand side of the picture but is covered by clouds, and the Pacific Ocean is on the right. A well-defined cold front extends from the Mexican Gulf area and runs parallel to the curvature of the earth (which, incidentally, is the true curvature of the earth). Perhaps this demonstrates that rockets could be used for other than warlike purposes—meteorology, for example.

The *Viking* is the largest American-built single-stage sounding rocket and is produced for the U.S. Naval Research Laboratory by The Glenn L. Martin Co., Baltimore, Md. It is powered by a 21,000-lb. thrust rocket engine built by Reaction Motors, Inc., Rockaway, New Jersey. It weighs about 15,000 lbs., is 45 feet long and carries nearly 1,000 lbs. of cameras and scientific instruments. On its way back to earth the rocket disintegrates and the instrument section is lowered to the ground by parachute. The rest can be written off.

This composite photograph covers an area of about 600,000 square miles of Texas and Mexico.



Engineering Problems of Manned Space Flight

BY KRAFFT A. EHRICKE, SAN DIEGO, CALIFORNIA

That space travel is theoretically possible is today admitted by many serious scientists, including such outstanding names as Th. von Karman, G.A. Crocco and J. Ackeret. However it should be clear that such a technically and medically complicated project as a journey to the moon or to the planet Mars will need decades of preparation, with careful step-by-step advancement. Space travel is therefore a long-term programme whose individual development stages must first be discussed and clarified in theory.

The following remarks by the German-American Krafft Ehricke provide at least a good basis for discussion. They also disclose that the Convair Division of General Dynamics Corporation, to whose staff the author belongs, is already engaged in space travel studies.

Born in Berlin in 1917, Krafft Ehricke studied aerodynamics at the Charlottenburg Institute of Technology and worked in the power plant section of the Peenemünde Rocket Development Centre from 1942 to 1945. After the close of World War II he went to Fort Bliss, Texas, as a jet propulsion specialist and then moved to the Guided Missile Development Group of Redstone Arsenal, Alabama, as chief of the gas dynamics section. From 1952 to 1954 he worked for Bell Aircraft Corporation and in November 1954 joined Convair at San Diego, where he is a design specialist in the guided missile development group. Editors.

INTRODUCTION

In October 1942 the first V-2 rocket took off for a successful experimental flight. The cut-off velocity was about 5,500 ft/sec (1.7 km/sec), or 21 per cent of the local circular velocity[1], i. e. the velocity of an earth satellite in a circular orbit. The range was 157 nautical miles, or 0.73 per cent of the earth's circumference (21,600 n. mi.). Today, 12 years later, thinking is in terms of intercontinental missiles with ranges of the order of 25 per cent of the earth's circumference and cut-off velocities of 90 per cent of circular velocity.

No longer is the feasibility of an instrumental satellite a point of argument, but rather details regarding its utility and design. The development of supersonic, rocket-powered experimental aircraft, at least in the United States, indicates systematic efforts in the direction of very high-speed, manned rocket vehicles. The age of manned space flight draws nearer with growing rapidity.

However, while it is reasonable to expect instrumental satellites within the coming decade, manned space flight will require more time due to the additional difficulties involved in the return from space. The technical and physiological problems of hypersonic flight in the upper atmosphere must be solved before the first steps into space can be taken and a manned satellite be established. Finally, interplanetary flight requires the development of special vehicle systems and flight techniques.

Roughly speaking, there are four development phases toward interplanetary flight discernible today:

- The manned orbital vehicle (satellite rocket plane);
- The permanent space station (satellite);
- Interplanetary flight;
- Operations in cislunar and lunar space.

The manned orbital vehicle, capable of operating for a limited time at the outer fringes of our atmosphere, can be the outgrowth of present development work on large guided missiles, research airplanes, and special booster rockets or manned (winged) boosters for multi-stage rocket vehicles. The automatic vehicles will, in time, be perfected to guided space missiles (intercontinental), and to the orbital version (robot satellite), comprising various modifications of the instrumental satellite as the forerunner of the automatic (unmanned) earth-to-orbit cargo ship for the establishment and supply of manned satellites.

The manned vehicle line leads via the orbital passenger vehicle (satellite ferry rocket) to the establishment of a permanent, manned satellite, in conclusion of the second phase.

The third phase is characterized by expansion into cislunar space and is expected to culminate in flights to the moon (satellitory maneuvers and landing operations in lunar space). This phase comprises a number of activities, such as the establishment of temporary orbits where needed (e. g., satellite propellant depots in orbits of departure), and of additional permanent satellites. Another very important aspect is the development of suitable space ship systems, space flight techniques, and navigational methods. The space ship systems are specialized in regard to their functions, their propulsion systems, and their environmental provisions. Through the accomplishments of the third phase, man will have become truly "space-borne" and ready to undertake interplanetary operations.

*

Figure 1 correlates altitudes (or distances) and energy levels (in terms of velocity), and indicates the "minimum" propulsion systems required within practical technical limits of vehicle design. All terrestrial and orbital (satellite) operations up to lunar flight can be carried out with chemical propellants. In interplanetary flight the practical limits for thermo-chemical propulsion systems are probably our neighboring planets Venus and Mars. Beyond the adjacent interplanetary space more powerful propulsion systems will be needed, not only in order to permit such excursions with technically feasible mass ratios[2], but also in order to reduce the very long travel times needed for round trips. The interplanetary flight path for any such trip will be an ellipse whose apsides are located in the orbits of earth and target planet, respectively *(Fig. 2)*; travel time to Venus would be 2 years, but to Pluto as much as 92 years. It may be noted that the interplanetary energy levels indicated in *Figs. 1 and 2* are representative values only.

This is the general frame. It surrounds a colorful painting, composed of countless problems. Their great majority will ultimately condense to engineering problems, although they frequently originate in different fields of science.

FLIGHT INTO SPACE

Manned flight into space must rely, at least initially, on the multi-stage orbital vehicle with winged final stage. Orbital operation at 120 n. m. (223 km) altitude represents about the minimum energy level of manned space flight. Table I gives a survey of some of the most important "problem areas" for this task.

Propulsion

Energy shortage is a serious difficulty and makes propulsion the number one problem

[1] Circular velocity is the speed at which weight of the body (satellite) and centrifugal force (due to the circular motion) balance one another. It decreases with increasing distance from the earth; at an altitude of 100 km, for example, it is 7.85 km/sec; at 1,000 km only 7.35 km/sec. -Editors.

[2] In single-stage rockets, burnout velocity is equal to exit velocity of the propellant gases times the natural logarithm of the mass ratio; in multi-stage rockets it is obtained by adding together the values for the various stages.

area[3]. The following steps toward improvements or solutions are possible:

1. Improvement of the effectiveness of present-day propellants and motors.
2. Development of new high performance propellants.
3. Development of new propulsion systems.

Summarizing the possibilities of the first two steps, it can be anticipated that the limiting values for chemical propellant motors will be of the order of 4,000°K (7,200°F) chamber temperature, 70 atm (1,000 psia) chamber pressure and 450 lb.sec/lb. specific impulse, compared to presently attainable values of about 3,000°K (5,400°F), 34 atm (500 psia) and 250 lb.sec/lb. This means, the specific impulse of chemical propellants cannot even be doubled.

As regards the third step—development of new propulsion systems—the use of *atomic reactors for heating working fluids* (for so-called thermo-nuclear rockets) provides a practically unlimited energy supply. However, the combustion process is now replaced by a heat transfer process and the efficiency of energy conversion is very low. A reactor of low critical mass and high operating temperature must be developed. The considerable weight requirements for shielding the crew and probable restriction of the use of such power plants to upper stages, in order to avoid launching site contamination, are distinct disadvantages of this propulsion system.

The ultimate solution to the propulsion problem is the *atomic rocket*. The energy which can be converted to thrust by these systems is one to ten million times the amount obtained with working fluids of propellants, hence the

I. Research programme for flight into space

SYSTEM	PROPULSION	AERODYNAMICS	FLIGHT MECHANICS	STRUCTURE & DESIGN	OPERATION
Multi-stage orbital vehicle with winged upper stage	Chemical thermo-nuclear atomic radiation	Powered ascent	Deflected trajectory	Multi-stage rocket vehicle	Man-monitored
development from: ballistic rocket research airplane manned booster	combustion research propellant research heat transfer cooling & heat protection thermodynamics & fluid mechanics of dissociated & ionized matter corpuscle-photon conversion	aerodynamics of ascending multi-stage rocket vehicles upper atmosphere	energy minimization thrust program tracking requirements stability, control elasticity	design staging methods weight minimization panel buckling & flutter Power plant integration high-temperature materials	systems optimization operational analysis human integration servo systems automatic guidance & control measuring & instrumentation telemetering communication navigation

[3] The main problem of flight into space is the large difference in energy level between the surface and space. According to Newton's law of gravitation the attraction of the earth (or any other body) at any point of the gravitational field is calculated from the formula $f = G \times m_1 m_2/r^2$, where f is the force of attraction (in dynes), G the general gravitational constant (6.67×10^{-8} dyne cm^2/g^2), m_1 and m_2 the masses involved, e.g., earth mass and mass of body (in grammes) and r the distance between the two centres of gravity (in cm). On the earth's surface each gramme of mass "weighs" approx. 980 dynes, at 1,000 km altitude only 730 dynes. To leave the earth's field of gravity permanently at "escape velocity" (11.2 km/sec) would need no less than 14.9 kcal of energy per gramme of mass; for continued circulation round the earth (e.g., at 220 km altitude, i.e., at a circular velocity of 7.8 km/sec) 7.6 kcal/g would suffice. Editors

Fig. 1: The energy required for space travel can be expressed in terms of the "ideal velocity", i.e., the velocity (in 1,000 ft/sec) which the space ship would reach after uninterrupted supply of energy. This value (abscissa) depends on altitude or distance from destination (ordinates in nautical miles). The thin lines denote the terrestrial class, the thick lines the orbital class and the broken lines the astronautical class of vehicle. The limits of application of the various propulsion systems are also shown.

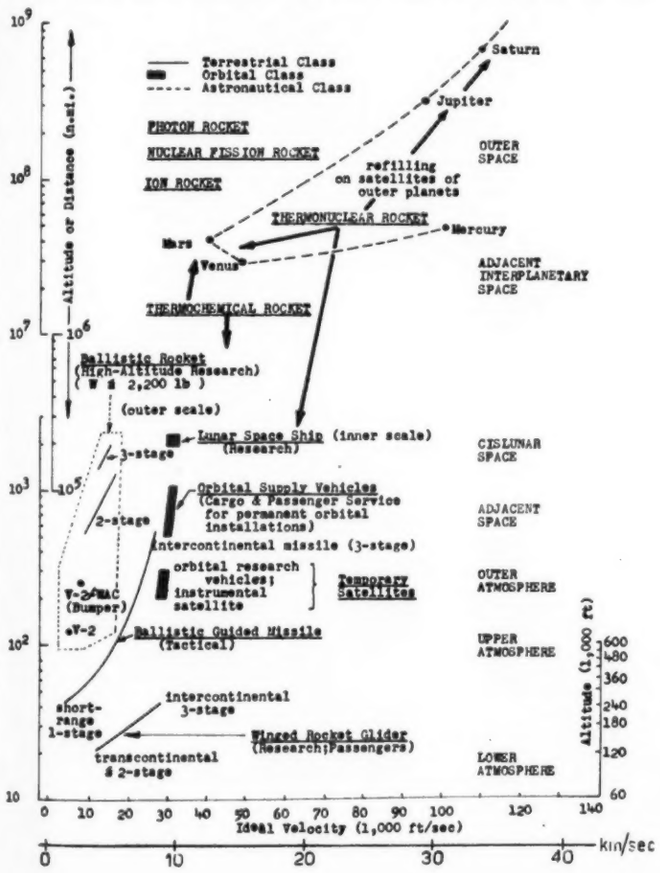
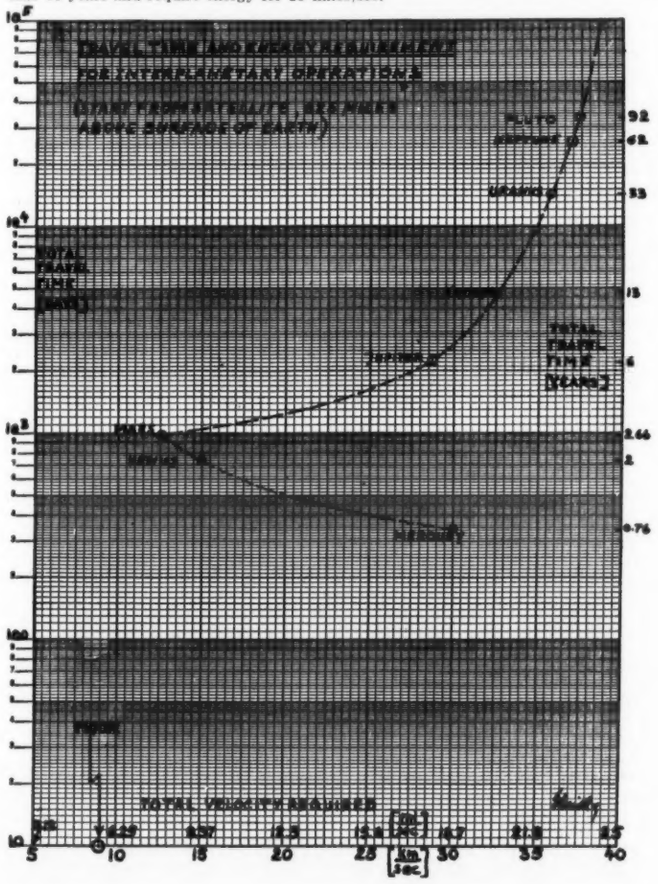


Fig. 2: Total travel time in days (lefthand ordinates) and years (right) and energy requirement (ideal velocity in miles/sec and km/sec) for interplanetary expeditions, when the space ship starts out from a satellite circling 625 miles above the earth. – For example, the round trip to Venus would take about two years and need energy for an ideal velocity of 9.4 miles/sec. A visit to the planet Pluto, on the other hand, would take 92 years and require energy for 23 miles/sec.



specific impulse is 1,000 to 3,000 times as large. Obviously, interplanetary flight would be reduced to the routine level of present-day commercial aviation if such propulsion systems became available.

Aerodynamics and Flight Mechanics

Aerodynamically speaking, flight into space is a matter of powered ascent through the atmosphere. The tropospheric flight velocities are low and the vehicle passes through a stagnation pressure maximum, usually 30 to 60 seconds after take-off, in the low velocity range between Mach number 1 and 2. The basic aerodynamics in the velocity and altitude range of such ascending vehicles is well understood. Special problems arise, however, due to particular shapes, due to large changes in mass and due to high flight accuracy requirements. Depending on the staging method, more or less difficult aerodynamic and stability problems can be encountered.

Analysis of deflected trajectories from vertical ascent to horizontal flight direction at circular velocity is also needed. *Fig. 3* shows the three principal methods of ascent. In the order of increasing energy requirement they are: elliptic ascent, ballistic ascent and powered-all-the-way (PAW) ascent. The PAW ascent is too expensive for ascents into orbits much above 125 to 150 n.mi. The ballistic ascent has advantages under certain conditions, for instance, when, for tracking purposes, visibility up to the apogee is required.

Structure and Design

The preceding considerations ultimately must be condensed to certain design requirements with regard to power plant integration, staging methods, fuselage design and cockpit design. Power plant integration involves in particular the selection of the propellant. The data and considerations involved here are very complex but specific impulse and density are of particular significance.

Staging is the most effective method of compensating for the energy deficiency of propellants and working fluids. A variety of staging methods is conceivable and has been considered, such as arrangement of the stages

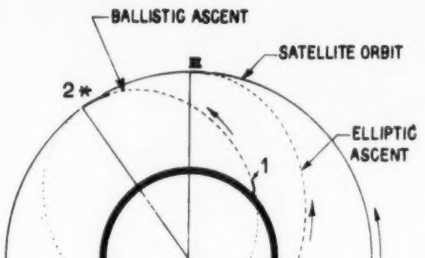


Fig. 3: There are three methods of ascent to orbital altitude. These are, in order of increasing energy requirement: elliptic ascent, ballistic ascent and powered-all-the-way (PAW) ascent. For the elliptic ascent, I is the point at which local circular velocity is reached, II the point at which perigee velocity of the transfer ellipse is attained, III the apogee transfer into the target orbit after re-ignition of the rocket motors. – The ballistic ascent also requires two separate propulsion periods – (marked 1 and 2).

in series, in parallel[4], a hybrid arrangement and telescope staging. Examples are shown in *Figs. 4, 5 and 6.*

For orbital vehicles with chemical propellants three stages are required. Series arrangement simplifies comparatively the separation of the stages (staging), but does not utilize the upper stage engines until after the respective staging. The requirement for reliability of engine starting is high, because a maximum number of motors must be ignited in flight. If the upper stage is winged, arrangement in series puts the center of pressure of the overall vehicle farthest forward, requiring large and heavy tail fins for establishment of the necessary stability margins.

Parallel stage arrangements avoid these shortcomings. All motors can be ignited on the ground, whereby engine weight is saved, and operational reliability is increased. The wings of the upper stage are in this case at or near the vehicle's center of gravity, which results in much more favorable stability conditions and eliminates the need for fin balancing.

[4] cf. G.A. Crocco "Reaching for the Stars", *Interavia* No. 1, 1955, pp. 22-23.

Another important problem is the recovery of booster stages, as the economical requirements of any sustained orbital operation, such as satellite maintenance, practically demand their recovery and repeated use. One possible way of recovering the first stage, which does not attain an extremely high velocity, is by means of parachute, though this is probably not practical for the second stage, whose cut-off velocity is so high that severe aerodynamic heating would occur during descent.—In the case of parallel staging it is comparatively simple to provide the first stage with wings which enable it to glide back to the ground like an airplane. This recovery method appears considerably more attractive and justifies the resulting increase in overall take-off weight.

Hybrid arrangement in the form of telescope staging *(Figs. 6 and 7)* avoids parallel staging where it is least attractive, between the first and the second stage. Recoverywise this means parachute recovery of the first stage and wing recovery of the second.

Probably the most complex problems in structural design will be imposed by the necessity for low-weight (thin-shell) design, in the face of high loads, high supersonic speeds and considerable aerodynamic heating. These problems include thermal stress and material strength.

Operation

Operationally, the orbital vehicle is man-monitored. This means that the vehicle is equipped with fully automatic guidance and control (autopilot system) which in turn is supervised and monitored by a pilot. In connection with the operation of this vehicle, a number of development problems are named in the lower portion of the last column of *Table I.*

DESCENT TO EARTH

During descent the large quantity of energy accumulated for flight into space must be dissipated without destroying the vehicle or its inhabitants. As long as considerably more powerful propulsion systems are unavailable, the only possibility on hand is dissipation in the atmosphere. Consequently, aerodynamics, in the broadest sense, becomes the number one problem area for this mission.

Fig. 4: Drawing of a four-stage space vehicle featuring staging in series, with winged final stage and massive guide vanes on the first stage. (Copyright: *Walt Disney Productions*).

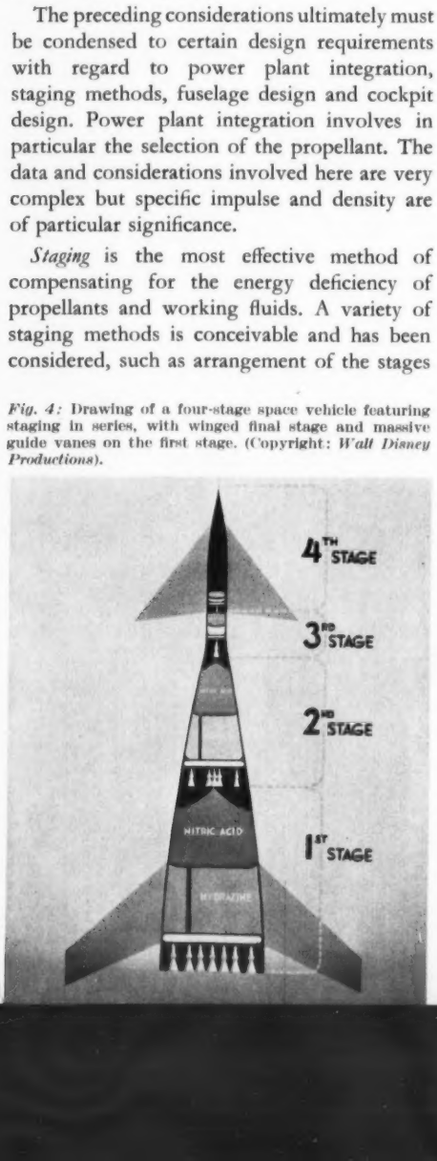


Fig. 5: Model of parallel staging for a three-stage space vehicle with wings on all stages, as proposed by Professor *G.A. Crocco*, Rome.

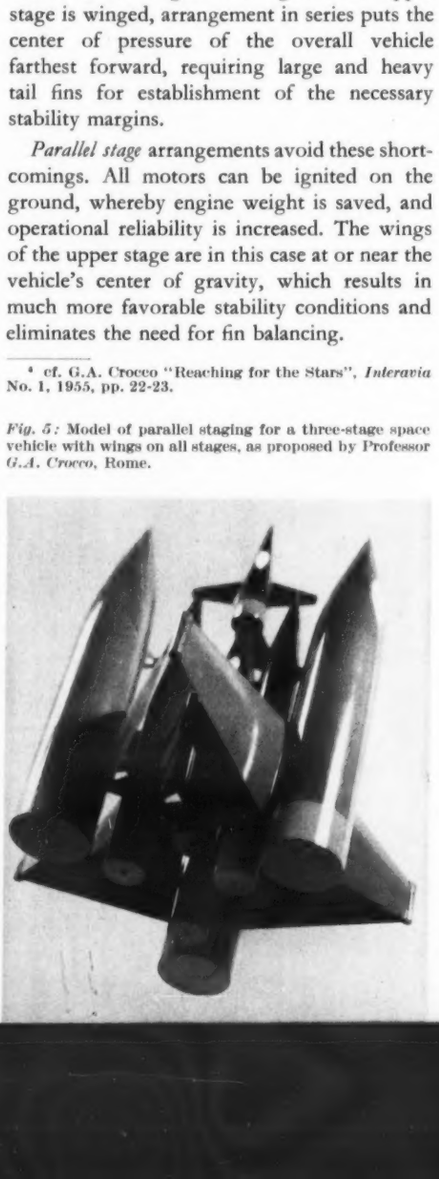
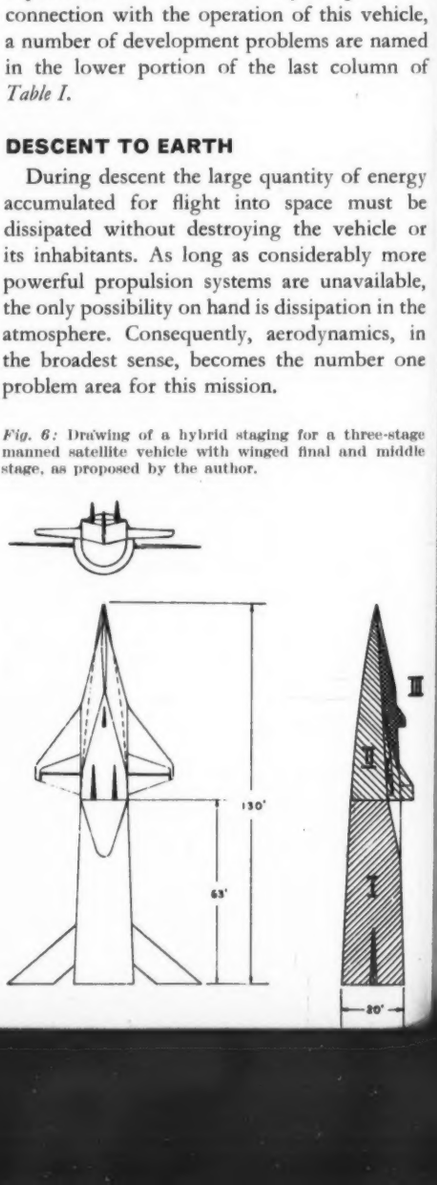


Fig. 6: Drawing of a hybrid staging for a three-stage manned satellite vehicle with winged final and middle stage, as proposed by the author.



Aerodynamics

One very effective means of energy dissipation is the *hypersonic glider configuration*. The word hypersonic indicates very high flight Mach numbers ($1/M \longrightarrow 0$). In contrast to a long-range glide vehicle for which high lift at low drag (a high L/D ratio) is essential, the returning orbital glider should produce high lift *and* high drag. The drag is required for braking the speed, while high lift is important in order to restrict the braking process to the highest possible altitudes, thereby reducing the intensity of aerodynamic heating. This reduction in heating is accomplished by minimizing the pressure in the boundary layer.

The skin temperatures depend on a number of parameters which cannot be discussed in detail. Lower temperatures are expected with laminar rather than with turbulent boundary layers. Fortunately, theoretical and experimental indications are that the boundary layer will be laminar most of the time. It is also possible to reduce the skin temperature by fluid injection into the boundary layer and by good thermal transport from the hot to the cool side of the wing, i. e. from the windward side to the lee side. Although heating should not be considered lightly, a closer look at the associated problems nevertheless indicates that a determined effort can provide the temperature-resistant materials and insulation required.

Flight Mechanics

The vehicle enters the atmosphere along an elliptic path until the speed is reduced to local circular velocity, at which point the angle of attack should be zero. At sub-circular velocity the angle of attack increases with decreasing speed, until a practical limit either of lift or of maximum wind-side heating is reached.

Thus, for some time after re-entry, the vehicle should not be compared with a conventional airplane. For instance, at an altitude of 220,000 ft (70 km), the flight Mach number is 14.5 for a lift parameter of 0.01, and 16.9 at 0.005. The corresponding dynamic pressures are, in round numbers, 51 lb./sq.ft. (0.024 atm) and 70 lb./sq.ft. (0.033 atm), respectively. These low dynamic pressures represent the only external forces available to aerodynamic control surfaces. Although aerodynamic control can be exercised in principle under such conditions, the low pressure leads to a considerable sluggishness (unacceptably long response times of the control forces to a given control command) which could be remedied only by very large control surfaces with a correspondingly high weight. It must therefore be assumed that, consistently with the high lift parameter technique, jet attitude control will have to be kept active for a while after re-entry into the atmosphere. Not until speed and altitude are reduced much further will attitude control become unnecessary. With aerodynamic control taking over exclusively, the transition between inertial (space) flight and aerodynamic flight will be completed.

II. Research programme for the return to earth

SYSTEM	PROPULSION	AERODYNAMICS	FLIGHT MECHANICS	STRUCTURE & DESIGN	OPERATION
Orbital Passenger Vehicle		Hypersonic Glider	Glide Path	Manned Glide Body	Man-Monitored
developed from: orbital research airplane		Aero-Thermo: compressible boundary layer dissociation shock-boundary layer interaction ionization radiation Hypersonic Aerodynamics Superaerodynamics free molecule flow	Transition from inertial to aerodynamic flight path oscillations stability & control deviation from great circle path gust load distribution	configuration skin & coating insulation high-temp. structural material cooling requirements thermal stress buckling & flutter creep fatigue	attitude control aerodynamic control power supply during glide communication navigation safety devices

ESTABLISHMENTS IN SPACE

After successful accomplishment of the first two missions, the state of the art is potentially adequate to proceed toward the development of manned establishments in space. Table III indicates that for this mission emphasis lies on the variety of systems and on design and operational implications. The systems involve temporary and permanent, powered and unpowered establishments.

The Satelloid

The "lowest" form of orbital establishment is a vehicle for which the designation satelloid is suggested, because it needs sustainer power to stay in circular orbit rather than being in inertial equilibrium like a satellite in space. Therefore it can operate at lower altitudes than satellites and the velocity can be circular or sub-circular. This vehicle is capable of a significant number of revolutions, provided its altitude is not too low. Therefore it has great potential value as a research vehicle in the transition from atmospheric to space flight.

Satellites

Manned satellites can be classified as observational satellites (permanent), temporary

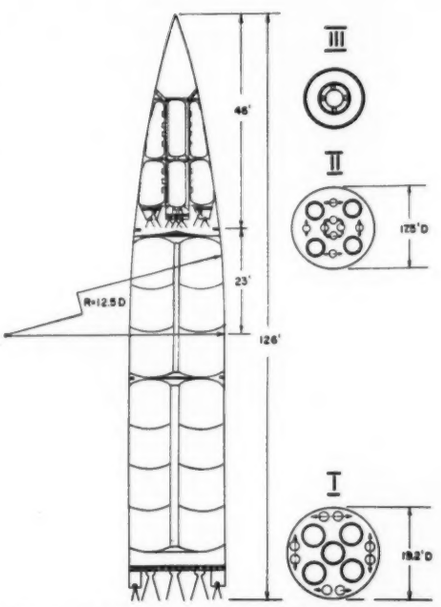


Fig. 7: Drawing of an unmanned three-stage supply vehicle for the establishment of satellites. This multi-stage rocket 126 ft. high and 19.2 ft. in diameter has telescopic staging; it was designed by the author for a final stage load of 11,000 lbs.

III. Research programme for establishments in space

SYSTEM	PROPULSION	AERODYNAMICS	FLIGHT MECHANICS	STRUCTURE & DESIGN	OPERATION
Orbital systems		Aerodynamics of the exosphere	Orbits	Supply ships Passenger vehicles Satellites	Man-Monitored
satelloid satellite: observational orbits assembly orbits auxiliary orbits (load transfer) orbits of arrival from outer space		dynamics of extremely rarified gases	mechanics of circular & elliptic orbits perturbations path correction	design of supply ships & passenger vehicles recovery technique satellite configuration structural design prefabrication assembly in space environmental technique	human integration attitude control power supply communication shuttle service

establishments for the assembly of astronautical expeditions, temporary establishments involving arriving astronautical expeditions and temporary auxiliary establishments for load transfer.

Observational satellites are concerned with scientific activities and terrestrial functions, pertaining to the earth as the abode of man. Orbital inclinations with respect to the equator should be high (45 to 75 degrees) for observational reasons. Orbital altitudes should be as low as permissible (600 to 700 miles), in order to keep the cost of maintenance from the earth down and permit maximum utilization of earth-scanning devices.

In *orbits of departure,* where astronautical vehicles are assembled, equipped and fueled for departure, the orbital inclination must coincide, at the time of departure, with the plane of the scheduled astronautical transfer orbit, and is therefore different from that of the observational satellite. The orbital altitude should be as low as possible. Due to the temporary nature of the establishment this means lower than the observational satellite (300 to 350 miles).

Orbits of arrival from interplanetary space should be very far out (30,000 to 50,000 miles), in order to minimize the energy requirement for return from interplanetary space.

Structure and Design

Establishment of orbital installations involves a comparatively large amount of material to be transferred within a relatively short time. *Maintenance* is concerned with small supply quantities over long periods of time. *Passenger transport* is a third type of mission, and different from either of the beforementioned tasks, but it is the same in periods of establishment and periods of maintenance. Separating passenger service from cargo supply permits a more functional vehicle design and economizes the supply process. For the period of establishment of a satellite, large vehicles are needed. Large payload capacity is of primary importance. An example of a large *automatic supply ship* is shown in *Fig. 7* for a useful payload of 11,000 lbs. The

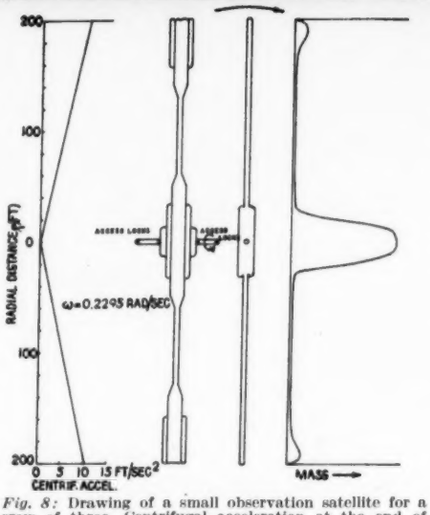


Fig. 8: Drawing of a small observation satellite for a crew of three. Centrifugal acceleration at the end of each 200-ft. extension is approx. ½ g.

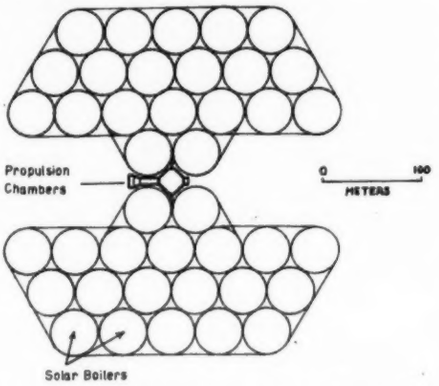
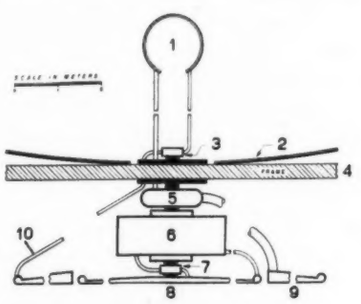


Fig. 9: Extra-atmospheric space ships are supplied by the sun with free radiation energy, which can be converted, as proposed by *E. Stuhlinger*, into electrical energy to accelerate metal vapour ions and electrons. *Below:* Cross section through one of the power stations in the Stuhlinger space ship: 1 – boiler; 2 – mirror; 3 – feed pump; 4 – frame; 5 – turbine; 6 – generator; 7 – cooler pump; 8 – cooler for generator; 9 – condenser; 10 – return lead.



absence of a human crew permits a light structural nose design with a high ratio of useful load to total weight, because no wings and safety devices are needed. On the other hand the *automatic maintenance vehicle* carries a smaller payload, and booster recovery becomes here of primary importance. *Passenger ship* design naturally must emphasize reliability and safety of return. A possible design, based on hybrid staging, is indicated in *Fig. 6.*

The wheel configuration which has frequently been proposed is attractive for very large satellites. For small satellites with a 3 to 5 man crew, which will come earlier, the wheel loses its main advantage of producing apparent gravity through the centrifugal effect, because this would require an increase in rotational velocity with decreasing wheel diameter. These difficulties can be avoided by giving small satellites a bar-bell shape, as indicated in *Fig. 8.* The heavy masses (power supply, air conditioning plant, some of the equipment) are concentrated in the center, while the crew space is at the end of two opposite rotating extensions.

OPERATION IN SPACE AND DESCENT TO OTHER CELESTIAL BODIES

The technical systems called out in *Table IV* involve a number of space vehicles with special functions. For landing on other planets, an "extra-terrestrial ground organization" must be developed.

Propulsion

For operation in cislunar, lunar, and interplanetary space typical vacuum propulsion systems such as the *thermo-solar* and the *ion propulsion system* can be added to the systems mentioned previously. Whereas the *thermo-solar* system simply uses mirror-focused solar energy for heating working fluids, the ion rocket represents an electric type of propulsion, accelerating ionized material and electrons in electric fields to obtain very high exhaust velocities at very low thrust, but long periods of operation *(cf. Fig. 9 and 10).*

Aerodynamics and Flight Mechanics

Aerodynamics will enter novel problem areas when descents to other planets become feasible. Inter-orbital flight mechanics involves a number of interesting and important problems, for example the analysis of optimum flight paths for given missions, including perturbations and powered maneuvers en route. These flight path perturbations offer an interesting approach to space flight economy, for instance by using the moon's perturbative action to attain the desired hyperbolic speed with respect to the earth at a reduced rate of fuel consumption. D. F. Lawden[5] recently

IV. Research programme for interplanetary flight

SYSTEM	PROPULSION	AERODYNAMICS	FLIGHT MECHANICS	STRUCTURE & DESIGN	OPERATION
Astronautical vehicles (Space ships) Landing craft	Chemical, thermo-nuclear, atomic radiation, thermo-solar, ion	Extra-terrestrial aerodynamics	Orbits Descent Ascent	Space ships Landing vehicles	Man-Monitored
vehicle types: passenger ship cargo ship lifeboat rocket moon landing craft extra-terrestrial landing gliders extra-terrestrial ground organization	extremely high or extremely low pressure combustion effect of very low G-requirements on propulsion utilization of solar energy electric propulsion effects of very long travel times	physics and chemistry of extra-terrestrial atmospheres aerodynamics of extra-terrestrial descent and ascent	spiral orbits perturbation maneuvers powered maneuvers in space descent to surface powered ascent relativistic flight mechanics	design of space ship & landing vehicles propulsion system integration design of extra-terrestrial ground equipment prefabrication assembly in space effect of long travel times & wide variation of environmental conditions	operations: cislunar lunar Mars & Venus satellites of outer planets reliability of operation space navigation communication

[5] cf. D.F. Lawden: "Perturbation Manœuvres" in the Journal of the British Interplanetary Society, Vol. 13, No. 6, Nov. 1954.

investigated this case and found an energy saving of about 50 per cent for departure to Mars.

*

Among the neighboring planets, Mars appears to be the most attractive first target for a number of reasons: the voyage requires the least amount of energy *(Fig. 2)*, the Martian gravity field is weaker than that of earth or Venus, the atmosphere is transparent and calm, the Martian topography is better known than that of any other planet, and the chances are good that the explorers will find at least low forms of life. The round trip travel time to Mars is longer than one would desire for a first expedition (2.66 years), but cannot be reduced substantially, even with considerably greater energy expenses than assumed in *Fig. 2,* because the periods of the two planets are so close that most of the round trip time is not spent in the transfer, but in *waiting* for the correct return constellation of Mars and earth. Therefore, the total time will stay above two years.

CONCLUDING REMARKS

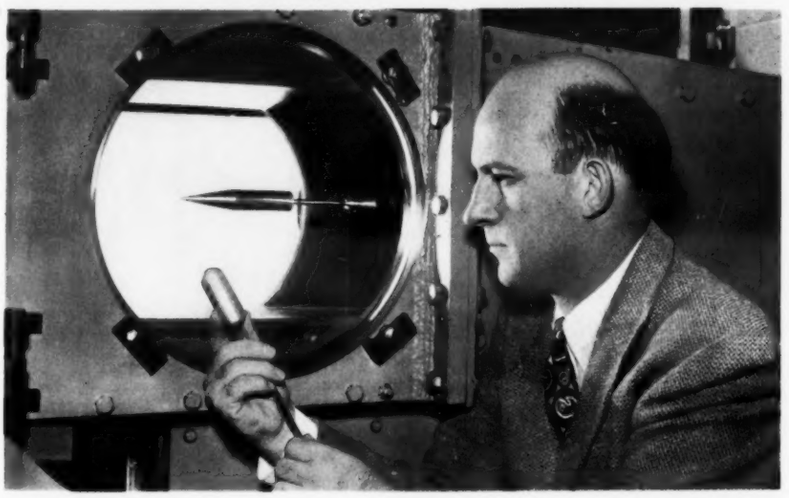
The preceding, rather cursory survey of the engineering problems of manned space flight suggests two principal conclusions:

1. The number as well as the severity of the problems ahead is formidable. This impression would be further augmented if the additional problem spheres, such as medicine, other sciences, economy etc. were added to the survey.

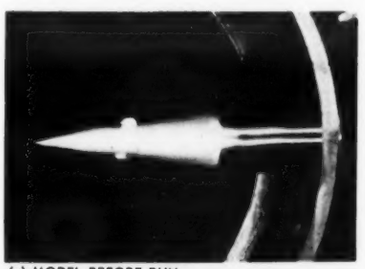
2. There is no apparent limit to engineering and scientific progress in this field of space flight. Its progress to full maturity will exert a deep influence on all mankind in the centuries to come.

The first conclusion illustrates the grandiose effort required to penetrate, technically, the field of manned space flight. The ultimate answer is implied in the second conclusion. From the viewpoint of mankind as a whole, the only lasting significance of manned space flight lies in man's ability to spread eventually life from earth into the surrounding universe and to develop methods of existence favorable for further anthropological development on other celestial bodies. Nobody has expressed this great concept more beautifully than the Russian pioneer of the space flight idea, *Konstantin Ziolkovsky,* at the end of the last century. If such possibilities are truly established on the basis of our present work toward space flight, the required efforts will appear compatible with the mission. These efforts, I am sure, will find the support of all civilized mankind and will be carried forward jointly by the scientific and engineering team into the cosmic age.

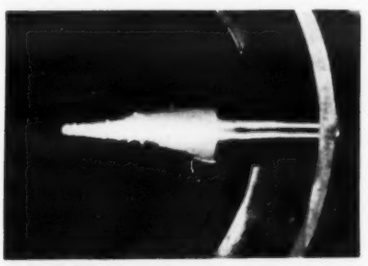
N.A.C.A. INVESTIGATES THE "HEAT BARRIER"



The National Advisory Committee for Aeronautics has been carrying out a series of experiments in its Langley Aeronautical Laboratory near Hampton, Virginia, to investigate the melting of bodies due to aerodynamic heating. Tests were made in the Laboratory's 11-inch hypersonic tunnel under the supervision of Charles H. McLellan (top picture). The latter states that melting of the surface of a body under the influence of frictional heating is today known to be "an orderly and reproducible process". It would thus appear to be possible to build high-speed vehicles which would remain intact, except for melting of parts of their skin, on plunging through the earth's dense atmosphere. A metal with low melting point (Wood's alloy, 70° C) was used for the tests, and speed of flow corresponded to Mach 6.9. Air temperature in the test section was approx. — 200° C, resulting in a stagnation temperature of about + 370° C. In the series of tests illustrated in the lower picture the conical tip of the model had completely melted away after 48 seconds, while the cylindrical end portion remained intact. During a certain period of time (picture *d*) a thin layer of molten metal could be retained on the surface, but when it became too thick it was shed suddenly. Picture *a* shows a paper ring which was blown away at the beginning of the air flow to indicate zero time on the test films.



(a) MODEL BEFORE RUN



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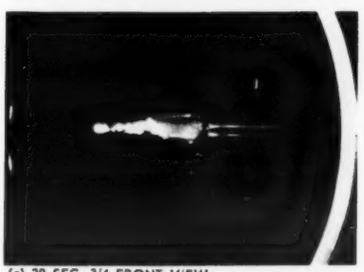
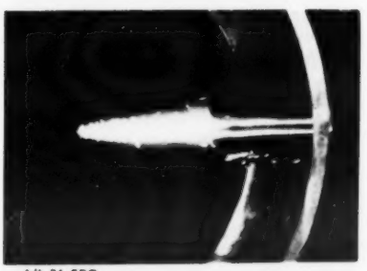


(c) 20 SEC. 3/4 FRONT VIEW



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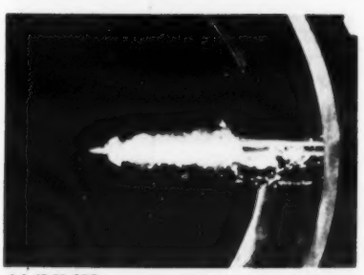

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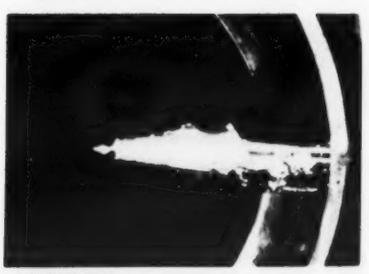


(f) 47.56 SEC.

The Air Hostess Told Us...

Martian without tears

"I kiché ten ti si ké di êvé dé étéche mêné izé bénézée," Esmeralda was declaiming. As usual, our Favourite Air Hostess had made herself comfortable at our editorial desk while we were out having our morning coffee. With her hand over her eyes, she was concentrating hard and trying not to look at the book in front of her. "I kiché . . ." she began again, beating time with a pencil on the table. — Stop babbling, we interrupted her, what on earth are you up to now? Me? . . . i kiché . . . I'm learning Martian of course . . . ké di êvé . . . I've applied for a job as a space hostess. You must lend me some dope on spaceships—but quick. It's going to start any day. My dear girl, we said, you've had it—you'll certainly get some space shortly—confined, padded, in a loony bin. Nevertheless we looked over Esmeralda's shoulder at her book and there, on page 205, was the extraordinary sentence she'd been repeating, with the French translation underneath: "O why do you not stay with me always, dear friend regained."

Such ridiculous phrases are only to be found in language textbooks. Esmeralda was obviously speaking the truth, she was learning Martian.

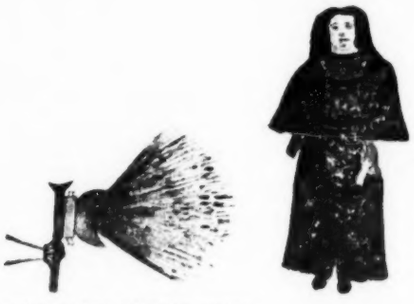
We looked at the title: "Des Indes à la Planète Mars," by Th. Flournoy, Professor of Psychology at the University of Geneva. Date of publication, November 1899.

There you are, says Esmeralda, that just shows you how uncultured you are, and you ought to be ashamed of yourselves. For more than fifty years there has been a complete handbook on the Martian language, with vocabulary, grammar, phonetic spelling, in fact, everything that's needed, and *Interavia,* which will obviously become *Interastra* in the course of time, hasn't even the foggiest idea of it. When you're invited to Trans Planetair Lines' inaugural flight you won't even be able to say how do you do to the Mars men or haven't we met some place before to the girls.

Enough of your impertinence, we growled, stubbing out our cigarette. Where will you get with your fine Martian if Mars is closed because of low cloud and rain and you have to land on Venus instead?

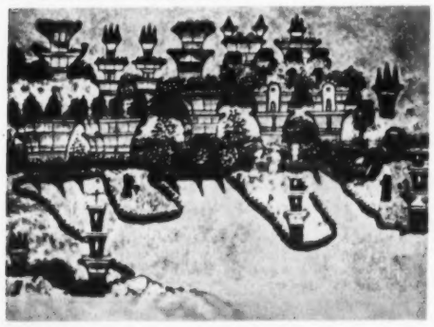
Very funny, says Esmeralda. The joke is, there's practically no difference. I can read the Venus language as easily as falling off a log. And she pulled out a second book: "Flying Saucers have Landed," by Desmond Leslie and George Adamski. See, look at this photograph of Venus writing on page 113 . . .

Mars flowers and fruits.

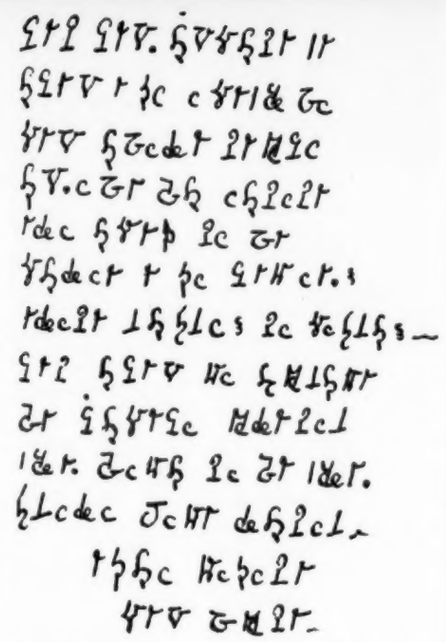


Astané and his jet flying machine.

Mars Town; a drawing made by Mademoiselle Hélène Smith on the spot. Note the anemometer on the roof of the house in the foreground.



Mars insect: pink body, green eye.



Hélène Smith, Geneva Psychology Professor Th. Flournoy's medium, made repeated journeys to Mars between 1895 and 1898, where Fakir Astané initiated her into the secrets of the Martian language. Prospective space travellers will see from this example that Martian is clear, straight-forward and easy to learn.

Believe it or not, the hooks and curlicues on the two documents were suspiciously similar. Martian and Venusian cannot differ much more than English and American, for instance.

We were still not altogether convinced. O. K., so Leslie and Adamski got their Venus writing first hand, to be exact from the inhabitant of Venus who landed from the "Scout Ship" in the desert 10 miles from Parker, Arizona at 12.30 p.m. on November 20th, 1952. Even we have to believe this, seeing four witnesses swore to it before C. D. Mc Cauley, a Notary Public in the State of Arizona . . . But will you please tell us, if you can, where your precious Geneva professor got his Mars language from.

I've been waiting for that, brilliant, smirked Esmeralda. It couldn't be more authentic. Professor Flournoy's faithful assistant, his medium Mademoiselle Hélène Smith, who gave him 186 séances free, took the trouble to go to Mars several times in person to collect the information and check the whole thing with Astané, the Mars fakir.

Fine, we admitted, you win. Still, the medium seems to have been a lot happier about it than the professor. Read for yourself what he says in his preface: "I have decided to publish it after all—as an example not to be followed—so that I need not think of it again. I will console myself with the thought that nobody is obliged to buy or to read the book."

But here the professor was mistaken. His Mars book sold like hot cakes. Within a short time it had run into six editions. And if the publishers should decide on a re-issue, we reckon they'd be just as successful again. Everyone is pretty fed up with the earth as it is today.

Rocket Research and Production in Italy

BY GENERAL ALDO URBANI, ROME,
FORMER CHIEF OF THE ITALIAN AIR STAFF

The author of this article, General (ret.) Aldo Urbani, is the President of the Italian Jet Propulsion Research Centre (Centro di Studi per la Propulsione a Reazione) and thus obviously is an expert in the field of rocketry. Within the limits of this N.A.T.O. member's security regulations, the author pencils a rough sketch of Italy's work in the field of rocket development. *Editors.*

The need for research and development in the guided missile field is fully recognized today also in Italy, particularly in view of the fact that these weapons seem to be destined to usher in a new era of arms engineering. It should be pointed out, however, that the enormous engineering and financial resources required for this type of work have so far permitted the materialization of only relatively modest projects.

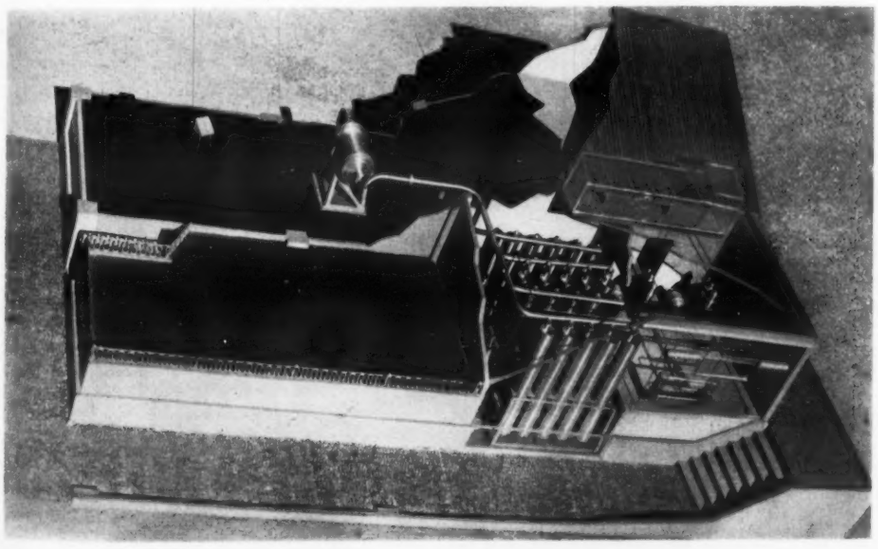
At the request of the Italian General Staff a Rockets and Missiles Committee (*Razzi e Missili*) was formed initially by representatives of all three Services. It is the task of this Committee carefully to study, coordinate and —according to their merit—actively sponsor the various projects put forward by Italian industry and, chief of all, to establish close cooperation between scientists, industrialists and the competent officers of the armed forces.

A second official advisory body was created in the form of the *Centro di Studi per la Propulsione a Reazione* which groups together a number of first-class experts on rocket propulsion. The duties of this institute are defined from case to case by technical and financial agreements between the Italian Ministry of Defence and two of the country's major industrial groups. At the present time the *Centro* is engaged in the development of the prototype of a *guided air-to-air missile* which already has aroused keen interest among the military procurement agencies.

*

In order to provide fresh impetus to scientific rocket research the Ministry of Defence ordered the construction of a *modern supersonic wind tunnel* at the *Scuola d'Ingegneria Aeronautica* in Rome. The wind tunnel is of the open-circuit type and therefore operates intermittently; it is equipped with the most modern optical and electronic measuring and recording instruments. Speeds between Mach 1.5 and 5.0 can be reproduced; maximum Reynolds numbers range from 30×10^6 to 40×10^6, i.e., they are very high. Incidentally, the new Rome wind tunnel is at the disposal not only of Italian industry but also of that of the Allies and has already been used for numerous aerodynamic studies of missiles and rocket bodies.

Model of the aerodynamic research installation at the *Scuola d'Ingegneria Aeronautica*, Rome.



At the aerodynamics institute of the *Politecnico di Torino* three flow-research installations are under construction: (1) *A "Göttingen"-type subsonic wind tunnel* driven by a 1,000 kW DC motor and capable of working at pressures up to 42.7 lb./sq.in. (3 kg/cm²) and low pressures down to 4.75 lb./sq.in. (⅓ kg/cm²); max. Reynolds number 4.5×10^6 for an airfoil of 400 mm = 15.75 in. chord; (2) *a "Zürich"-type closed-circuit supersonic wind tunnel,* driven by the same motor as (1), for speeds up to Mach 2.3; (3) a *transonic tunnel* (derived from 2), with a special nozzle for continuously variable Mach numbers up to 1.3. Furthermore, a test bench for axial flow compressors (350 kW at 3,000 r.p.m.) is nearing completion.

Similar equipment is under construction at *Naples University* and by several industrial firms.

*

On the other hand, the Italian Air Force has started the preparation of a large *rocket range* at an extremely well suited site in the Peninsula. The new experimental station will also be equipped for testing guided missiles.

Of recent rocket developments in Italy particular mention is deserved by two *ground-to-air anti-aircraft-missile* prototypes powered by liquid-propellant motors; though they are

not guided at the moment, they are to be converted into guided missiles in the course of their development. The two types, created by different designers, feature several important technical innovations, particularly as regards propellant combination and the method of supplying the fuel to the combustion chamber. It should be noted here that the two companies engaged on these developments have their own, well-equipped rocket test beds.

Several other firms are working on *unguided combat rockets*. Two types of especially simple design, great reliability and wide versatility (different kinds of warhead can be mounted) have already been supplied to the forces.

Finally, an allusion should be made to the strenuous efforts undertaken by numerous firms of the *equipment industry*, particularly the electronics companies, in support of Italian guided missile development.

Test firing of an "Orione" unguided rocket.

*

All this amounts to a very summary sketch of Italian efforts in the rocket field. It is fully realized in Italy that huge financial and engineering resources, as well as first-rate scientists and engineers are required if any progress is to be made in missile development. Naturally, Western European cooperation similar to that now planned for other segments of European defence would greatly accelerate research, project engineering, standardization and production of the new weapons. Italy, who certainly does not lack scientific tradition, is determined to work towards such cooperation and could furnish a very positive contribution.

Aldo Urbani

Sweden's Guided Missile Programme

Although guided missile research in Sweden was probably inaugurated much earlier, it was not co-ordinated until the formation in 1948 of the "Försvarets Robotvapenbyrå" (Defence Guided Missiles Bureau) within the Kungl. Flygförvaltningen (Royal Swedish Air Board, i.e., the Air Force research and development organization) which was charged with development work in this field. At the same time there was established the "Försvarets R-vapenråd" (Defence Guided Missile Council) to follow development in Sweden and elsewhere of rockets, guided missiles and recoilless weapons in order to be able to make recommendations concerning Sweden's defence preparations in these fields.

Contrary to what is the case in certain other countries, Sweden's guided missile programme—or as much of it as has been revealed in the Supreme Commander's Defence Modernization Programme—reflects much of the utility thinking that has proved so successful in Sweden's piloted aircraft development and production (the Saab J 29, etc.).

Before fiscal 1954-55 all Swedish missile development money came from other headings in the defence budget. This was the case, for instance, with the air-to-surface missile (attack missile in Swedish Air Force nomenclature) first mentioned in November 1952 in connection with the first flight of the Saab A 32 *Lansen* all-weather attack aircraft which, it was then stated, was "to carry Swedish-developed attack missiles by the time it enters service".

Last year, however, as the missile programme grew too vast to be covered by ordinary aeronautical development funds and as work was started on the most costly missile project so far—an air defence or interceptor missile for very high altitude defence—the Air Force received special missile funds and was authorized to start design and development of the interceptor missile within a cost limit of Sw.Kr. 25,000,000. Of this sum, a total of Kr. 10,000,000 has now been made available, of which Kr. 6,500,000 is for production (? Ed.). According to reliable sources, this Swedish missile is a more complicated design than the U.S. Douglas *Nike* and has a range of no less than 200-250 km (120-150 miles). The official description of this "luftförsvarsrobot" (= air defence robot) alone indicates that the missile is actually a pilotless fighter probably somewhat similar to the U.S. Boeing IM-99 *Bomarc*. Compared with rocket-propelled short-range anti-aircraft missiles (of *Nike* or similar types which are not suited for defence of other than very limited targets) the long-range air defence missile or pilotless fighter needs another kind of propulsion to obtain the range required. The IM-99 uses two ramjet engines in combination with a solid-fuel rocket motor to obtain this, and it is likely that the Swedish missile will have a somewhat similar propulsion system. In this connection it may be of interest to note that Svenska Flygmotor has been actively developing ramjet engines for some time.

This interceptor missile has been the most publicised because of the special appropriations provided for its development, and it is evident that this project is probably the most difficult so far entered upon in Sweden. It would, therefore, not be surprising if some other missiles became operational at an earlier stage.

In addition to the air-to-surface missile (= attack robot) intended to be carried by the *Lansen*, and the high-altitude interceptor missile (= luftförsvarsrobot), the Air Force is also developing an air-to-air missile (= jaktrobot) that will arm all Swedish fighter aircraft in the future.

The Swedish Navy, too, has a missile development programme, and so far it has been disclosed that the Navy is working on two types of missiles. One of these is a so-called naval missile (= sjörobot) which will constitute the major armament of the Navy's coming new missile destroyers. Successful tests have already been carried out with this missile according to official Navy statements, and the ultra-modern 3,000 ton *Halland* destroyer recently delivered to the Navy—believed

to have the world's most modern conventional destroyer artillery—will eventually be equipped with these new surface-to-surface naval missiles.

Already mentioned several years ago were the Navy's plans to replace its present heavy coastal artillery with special coastal defence missile batteries, whose much greater range would more than offset the greater mobility of conventional artillery. These coastal defence missiles may also be launched from bombproof underground stations. It would not be surprising if these plans had now left the paper stage.

As the first Swedish military service to do so, the Army already in 1951 organized the first missile field test unit within the artillery. It now seems that surface-to-surface Army missiles have little future in Sweden at least for the time being, but there is no doubt that the Army will eventually be equipped with specialized missiles for other purposes, such as for anti-tank use.

To sum up: It is certain that Sweden has spent more money and put more technical effort into the hush-hush missile field than most people believe. The Kr. 600,000,000 earmarked for procurement of "new weapons" (believed to include mainly missiles) between 1960 and 1965 is proof enough that Swedish guided missile development is not idle.

Parachutes Are Specialized

The parachute—which as recently as World War II was limited in use to the saving of air crew lives in emergencies, getting airborne troops to the ground in comparative safety, and a certain amount of supply dropping—has blossomed out into a variety of fields in the past few years. New functions today performed by parachutes include braking of aircraft, in which the chute acts like a sea anchor; recovery of non-expendable equipment; stabilization, or guidance, of streamlined objects in the air; and, of course, the dropping of extremely heavy loads. Sometimes the job can be done with one specially designed chute; others require a system of two or more chutes. Variables in the design problem are speed, function, shape, size and weight of load, atmospheric conditions, elevation, landing requirements as to precision and safety.

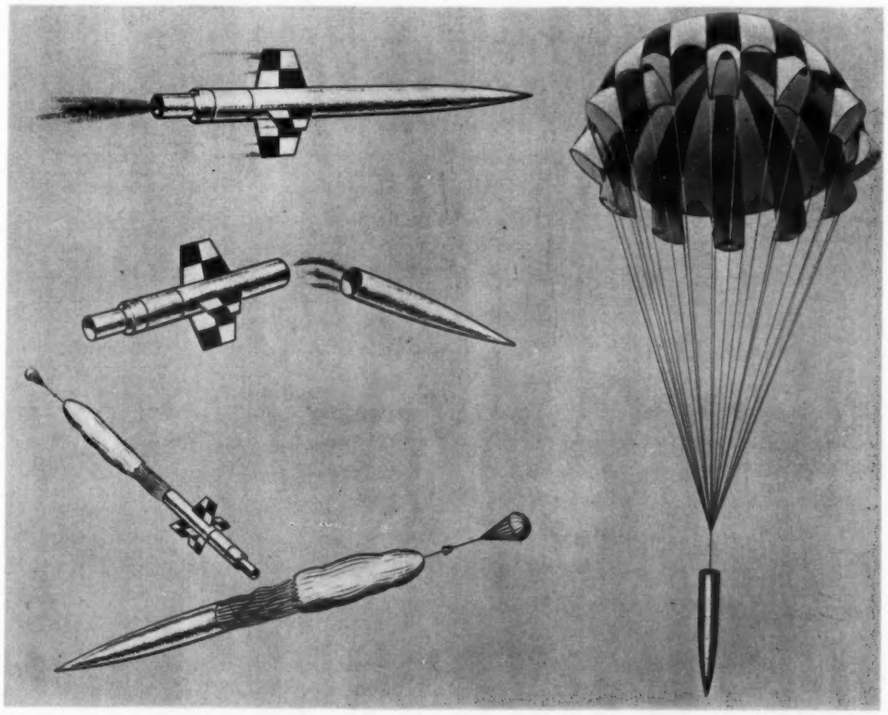
Recovery has become one of the most important functions of parachutes. There are many applications. The rocket type missile soaring hundreds of miles above the earth automatically records research data. Its mission completed, the missile separates in flight. The instrument and power sections are decelerated, stabilized and lowered safely to the ground by parachutes specifically tailored to meet the conditions of high speed and heavy load. In many instances, several deceleration phases are involved which necessitate the use of additional parachutes or special deployment methods to accomplish a successful recovery. Or, when recovery is accomplished by radio-controlled return, it is braked by a ring-slot or ribbon-slot or ribbon-type deceleration parachute. Every application requires its own specific type of parachute and equipment for safe landings.

Instrument-carrying balloons attain very great altitudes for meteorological studies. After the balloons have been automatically deflated, the instrument containers are recovered by a special system of both parachutes and suspension equipment. In another application, instrument "pods" carried by target planes permit parachute recovery of instruments and their precious records after the target is destroyed.

High-speed, self-propelled radio-controlled target planes, launched from the ground or from a ship at sea, are recovered in the air. The parachute is deployed by radio control from the ground, or automatically in emergencies, such as mechanical failure. More than 150,000 successful recoveries of such targets have been made in the U.S.A. Again, the recovery may be accomplished by a single chute or a series of chutes. Some types of towed targets are brought back to the landing area by the tow plane and are automatically disconnected from the tow cable upon contact with the ground. The parachute is deployed simultaneously, braking the speed of the target. Many targets have been re-used more than a hundred times. Here the special purpose parachute has effected enormous savings for the armed forces.

The growth in the importance of the parachute is exemplified by the evolution of the parachute industry. For example the Pioneer Parachute Company, of Manchester, Conn., U.S.A., was organized only sixteen years ago, shortly before the outbreak of World War II. It started with less than a thousand square feet of floor space and with only three or four employees. Today it has become an enterprise which employs about 500 people devoted exclusively to the manufacture of parachutes.

Sequence of a research rocket's mission (left, top to bottom): when it has completed its task the rocket missile separates. Instrument and power sections are decelerated, stabilized and lowered to the ground by parachute. A special pilot chute pulls out the main canopy. At right, a Pioneer Guide Surface Parachute.



The major portion of present production is *special purpose parachutes*, most of them designed and manufactured to perform duties that had not been thought of ten years ago.

In today's high-speed parachute operations, use of the conventional circular canopy is limited, because the high opening shock exceeds the physical limitations of the human body. The conventional canopy is also unstable aerodynamically, resulting in oscillations, side-gliding motions, spiralling and combinations of these effects. These actions tend to increase the rate of descent and sometimes cause the airman to be in an unfavorable position for landing. The answer to these problems is the guide surface parachute, and Pioneer Parachute Company has therefore arranged to take over the commercial and foreign rights to distribute this type of personnel parachute, specially designed for emergency bailouts at high speeds.[1]

Guide surface extensions are attached to alternate gores of the canopy, to control the flow of air into the canopy during the initial inflation or opening period of the parachute, reduce the sudden flaring out of the skirt and prevent "explosive opening" of the canopy. As the canopy expands, the extensions act as aerodynamic brakes against the sudden radial outward motion of the canopy skirt and provide a smooth, uniform opening, with minimum opening shock. In descent a considerable amount of air turbulence is created between the closely-spaced flow separation edges of the extensions, which increase the drag or "lift" of the parachute. The guide surfaces are tilted inward 45° to the direction of descent. Any deviation of the parachute from the vertical position deflects the air flow along the guide surfaces in such a way that the canopy is directed back to the vertical position.

A radio-controlled target aircraft is recovered by a parachute which is deployed by radio-control from the ground or may be deployed automatically in emergencies such as engine failure or fuel exhaustion.

The airman approaches the ground with the parachute in a vertical position, enabling him to land straight down on his feet. Hundreds of safe landings have been made from planes travelling at 450 knots. The performance characteristics of this parachute offer new and better possibilities for the safety of airmen escaping by means of ejection seats from disabled aircraft flying at high speed at low altitudes.

Stabilization, or guidance, of bombs, mines, torpedoes and streamlined objects is accomplished with other special types of guide surface parachutes, making possible a new degree of precision in mine-laying and bombing—maximum accuracy with minimum oscillation. Aerial-launched torpedoes are stabilized in their flight paths by these chutes, replacing conventional fins.

The high approach and landing speeds of jet planes demand a method of deceleration and braking which will insure safe landings even on short runways. For bombers, large ribbon-type brake parachutes provide the drag which allows the pilot to approach the field at a steeper angle. Smaller, ring-slot type brake parachutes are similarly used in jet fighter planes. In both of these heavy-duty applications the parachutes reduce landing hazards and cut down wear on tires and braking systems. New applications for parachutes are proposed and new designs for them are in the making—awaiting test.

[1] Cf. also: "Parachute Development in the United States", *Interavia Review* No. 2, 1954.

Esmeralda Again...

Chaps, says Esmeralda, as she busts into our office like a minor tornado, here I am again, the second time in this issue. We couldn't help noticing, we say, trying to be polite to our Favourite Air Hostess, what is the fuss about? Do you know the difference between you and me? she asks. Well . . . we say, we do know, but let's have *your* views on the subject.

Me, says she, when I work, at least I do so for a purpose. I feed passengers. I smile at old men to make them feel like they're eating monkey-glands. I'm even nice to women. The result? Air travel booms, INTERNATIONAL UNDERSTANDING is rampant, and I get a (very small) salary . . .

Hold on, we say, what do *we* do? We produce the world's best aviation magazine, sell it, and encourage people to fly with your ridiculous airlines . . . also for a (very small) salary.

Not so, replies Esmeralda. What you do is this: You sit at your desk. You try to look intelligent. You produce articles which I don't read. You get pictures. You have the stuff printed. And then the whole lot is confiscated. There's no purpose to it.

Confiscated? we scream. Sure, says Esmeralda, *confiscated*. Look at this issue. July, 1955. Four-colour Walt Disney rocket picture on the cover. Space ships and space men and satellites inside. And it's all S-E-C-R-E-T. Hence, confiscated.

And if you don't believe it, she says, look what I found in a Los Angeles newspaper—in Bill Kennedy's "Mr. L. A." column:—"Disneyland took some colour pictures of the model for their space ship and sent them to Eastman Kodak to have them developed. Weeks passed—and nothing. They just got the word—Eastman was holding them up to be passed for security in Washington, D.C. . . ."

Please, says Esmeralda, don't get mad at me. You can print everything I told you in your magazine. Nobody will read it, for the issue will be—confiscated.

The U. S. Navy's "Flying Platforms"

New One-man Puddlejumpers

Most people would hesitate to climb onto a board balanced on top of a sphere. Those who did succeed in this feat—and, moreover, while going up inside a lift in a six-storey building—would be qualified for the experiments which the National Advisory Committee for Aeronautics carried out in 1951. The object of these experiments, which were long kept secret, was to investigate a very unusual problem: is it possible to fly through the air standing upright on a jet-propelled platform of only a few square feet and to control stability and direction simply by moving the body?

At the end of a seven-month test programme two facts had been proved: 1 — a jet-powered vertical take-off device of this kind is quite stable in flight; 2 — the pilot need by no means be an acrobat. — The experiments provided valuable preliminary information for the development of new-type "one-man devices" as required by the U.S. Army and in particular the U.S. Navy. Experts of both services had long realized that a collapsible, portable and simply-operated vertical take-off device could render valuable services in commando operations (crossing rivers etc.), observation and rescue duties.

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As far back as 1946 C. H. Zimmerman, N.A.C.A. engineer in charge of the test programme, projected and built a small vertical rising hovering device, with contra-rotating propellers, that could be stabilized by a pilot standing upright. All that was necessary to obtain horizontal movements was to incline the thrust axis out of the vertical, i.e., to tilt the machine. The idea was based on the consideration that the instinctive reflex motions with which a man balances himself in a standing position must be transferred to the flying device in the right direction though perhaps not with the correct magnitude. The method of producing the lift (propeller or jet stream) has therefore no effect on stability, apart from the varying inertia moments.

Later Zimmerman found an enthusiastic assistant in P. R. Hill and from 1950 onwards was given full N.A.C.A. support. A new experimental device was built, with lift provided by a jet nozzle instead of the contra-rotating propellers. Its structure was extremely simple: a compressed air nozzle was let into a 19×29 inch piece of plywood in such a way that its thrust axis was perpendicular to the platform. The pilot stood on the platform, his hands free, but his feet held in cleats and tie-down straps. Underneath the platform was a four-legged supporting framework for take-off and landing. That was all. — The nozzle was supplied with compressed air via two fire hoses of equal length, which formed an elastic connection to a nearby compressed air container. All experiments were made at the Langley Pilotless Aircraft Research Station at Wallops Island, Virginia, where there was a large-capacity compressed air tank.

Several variants of the device were tried out during the tests. For example, several different take-off and landing supports were tested, as well as a pilot's seat consisting of a simple steel rod bearing a bicycle saddle. The rod was pivoted about a fixed point on the platform and had to be balanced by both feet. In all tests the pilot wore a parachute harness attached to a shock-cord suspension system carried by an overhead crane.

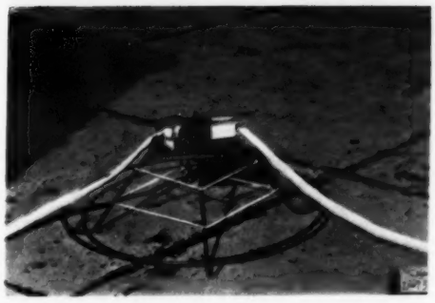
One surprising result was that the less the pilot consciously tried to steer the better he was able to maintain his balance. As soon as he looked down at the platform or up at the harness, he was lost: after violent lurchings the whole device suddenly tipped over and the pilot shot off in a horizontal position like a human rocket. Another surprise was that gyroscopic couples, displacements of the centre

First hovering tests with N.A.C.A.'s jet-powered platform. Two elastic fire hoses were used to supply compressed air to the jet nozzle.

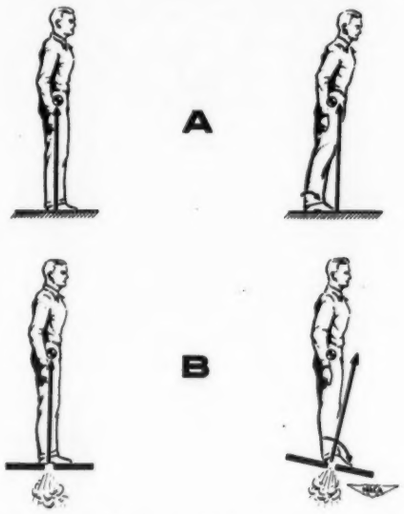
of gravity due to asymmetrical loads, unequal wind effects etc., originally expected to be disturbing, had no appreciable effect on stability and controllability. Within the available space limited by the length of the compressed air hoses, unexpectedly good manœuvrability was experienced in horizontal flight. Finally, the pilot found he could support himself by a vertical rod provided he continued to stabilize and control the device with his feet.

*

Following their successful experiments with jet-powered platforms, N.A.C.A. decided to test other vertical rising one-man devices. To investigate the obviously more complicated stability conditions in propeller and rotor-driven platforms, a test vehicle weighing 140 lbs. (illustrated on this page) was built at small cost in 1951. Lift was provided by a two-blade rotor 7 ft. in diameter, driven by two compressed air nozzles in the blade tips. Here too compressed air was fed via two fire hoses and passed through the hollow rotor hub and blades to the jet nozzles. A tubular steel framework resting on four legs includes a rail at hip level to protect the pilot. It also incorporates a steel platform 21 ins. in diameter which carries the rotor shaft bearing. The rotor and the plywood foot board were attached to the frame by inserting a sheet of sponge rubber between the board and the steel disc, thus providing a shock mounting. When the pilot, grasping the handrail, tilted the frame, the rotor followed the movement of the rest of the vehicle with a certain delay. The wooden foot board was rigidly attached to the rotor shaft, so that the pilot could "feel" the tilting of the frame in relation to the rotor, which was found to be important in the flight tests. During some of the experiments the teetering movement of the rotor blades was restrained by two springs, which noticeably improved both stability and controllability. The torque about the vertical axis produced by bearing friction



N.A.C.A.'s jet-powered one-man vehicle consists simply of a rectangular plywood board with compressed air nozzle and a four-legged tubular steel framework.



The instinctive reflex movements by a man balancing himself when standing upright on firm ground (A) are transmitted to the platform and ensure a balance of forces by tilting the thrust axis.

was compensated by releasing compressed air, regulated by means of a valve near the pilot's right hip, in the opposite direction to the rotor's rotation.

*

Flight tests of the rotor-driven platform gave the following results: 1) if the pilot controlled equilibrium and direction of movement solely with his feet, i.e., without holding on to the hand rail, stability and controllability with unrestrained rotor were satisfactory only in a limited range of flying attitude; an experienced pilot had little difficulty when he grasped the rail; 2) with spring-restrained rotor, stability and controllability were entirely satisfactory; 3) flights with rotor locked—when the rotor behaved as a propeller—introduced considerable difficulties. As soon as disturbances in balance or dissimilar air forces produced tilting in the vehicle, a precessional motion was started, which was not always easy to correct; 4) the ground effect not only gave good stability in the vertical but also imparted an angular (pitch and roll) stabilization when the rotor was within about two blade chords of the ground; 5) compared with the jet-supported platform, the rotor-supported platform flew more steadily in calm air but with larger oscillations in gusty air.

*

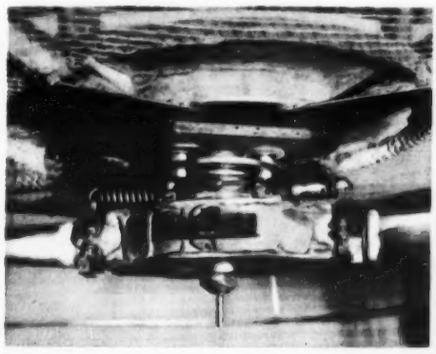
After completing their tests with manned vertical rising devices, Zimmerman and Hill finally built a small unmanned rotor platform with two contra-rotating propellers, using an electric motor for power. The model was remote controlled by means of command guidance, and current was supplied to the built-in motor via a cable suspended from the roof. — In January 1953 N.A.C.A. collected all results into reports which were then made available to a number of U.S. aircraft manufacturers.

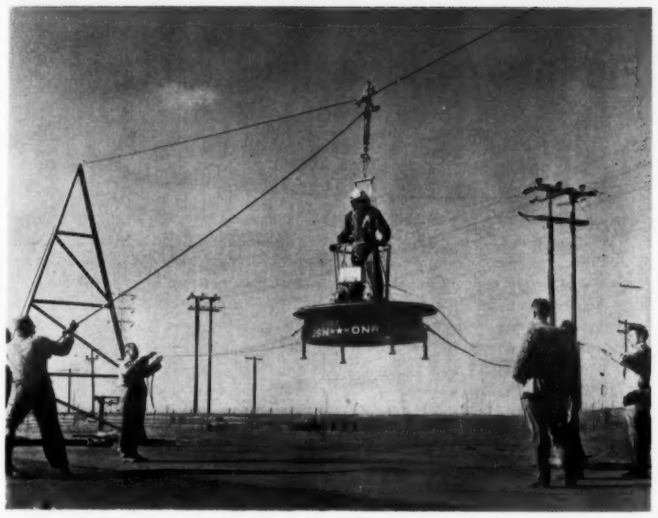
*

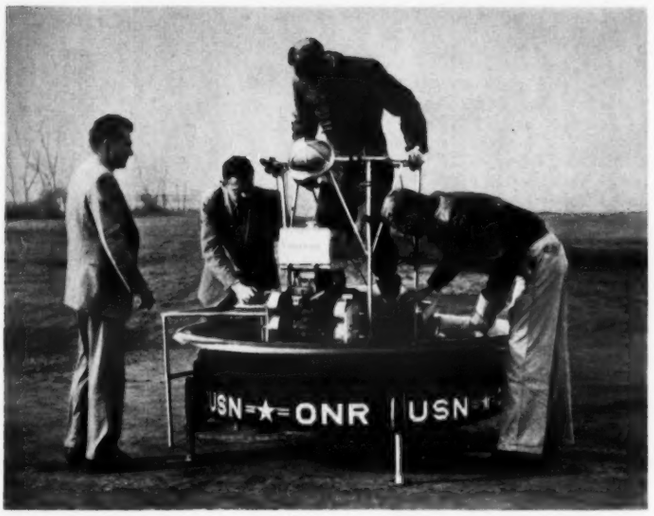
It was, however, some time before the industry brought out a development of its own. Admittedly, helicopter designer Stanley Hiller had taken an interest in Zimmerman's work as early as 1946 and had tested the latter's first "flying platform" in his factory. But these tests had to be suspended because of their constantly increasing cost. Then in 1953 the Office of Naval Research investigated means of sim-

Following the experiments with piloted platforms N.A.C.A. tested this remote-controlled model of a vertical rising vehicle with contra-rotating ducted propellers. Control is by means of small guide vanes fitted in the propeller stream.

Left: this one-man test vehicle for vertical take-off developed by N.A.C.A. weighs only 140 lbs. Lift is provided by a two-blade rotor, driven by two compressed air nozzles in the blade tips. *Right:* rotor hub with helical springs to restrain teetering when the rotor axis is tilted.







Hiller's *Flying Platform:* before the first free flight a number of tethered flights were carried out in which pilot and vehicle were protected from crash by cables. However, the vehicle really hovers, as may be seen from the "slack" in the ropes (but only with a magnifying glass).

plifying helicopter drives, for example by the use of the ducted fan principle. As chance would have it, Hiller's work on vertical take-off devices, for which ONR support was needed, was resumed at about the same time. ONR experts saw in Zimmerman's "flying platform" a suitable device for testing the ducted fan, and Hiller was the same year granted a development contract for a one-man VTO vehicle with contra-rotating ducted propellers. Successful tethered flights, in which pilot and platform were safeguarded by guide ropes, were followed early in 1955 by the first free flight.

*

Designated the "Flying Platform" by the makers, the vehicle consists in essentials of a 30-inch high cylindrical casing about 6 ft. in diameter, enclosing two super-imposed contra-rotating propellers. Air is drawn in by the two propellers, on the ducted fan principle, through the upper funnel-shaped opening and then ejected in a jet downwards. The thrust-increasing effect of the propeller casing is said to raise the thrust of the two propellers by at least 20%. The propellers are driven by two ordinary gasoline engines with a total power of less than 100 h.p. The pilot stands upright on a platform and holds on to a railing about hip level, steering the vehicle simply by moving his body, in the same way as the N.A.C.A. platforms.

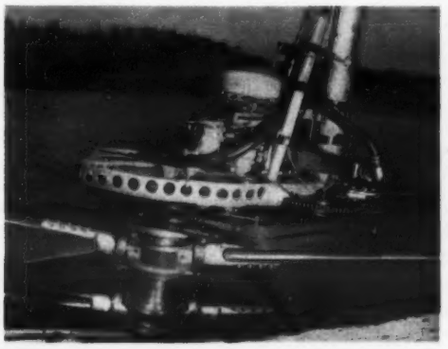
*

The DH-4 *Heli-Vector* designed on N.A.C.A. results by L. C. McCarty and under development at De Lackner Helicopters Inc., Mount Vernon, New York, uses a pair of non-ducted contra-rotating rotors. Recalling a conventional helicopter, this device is fitted with a 40 h.p. Kiekhaefer *Mercurey* motor (outboard motor for racing boats), which is said to give horizontal speeds of about 65 m.p.h. Weight of the prototype is 180 lbs., but this is to be reduced to 125 lbs. in the projected production model. In addition to the pilot it can carry payloads of up to 120 lbs.; endurance about one hour.

Today "flying platforms" are under development by a number of U.S. aircraft manufacturers. The majority of them are designed on the ducted fan principle. It remains to be seen, however, whether larger models for more than one "passenger" can be built. They would of necessity be heavier, so that "instinctive" control by means of body movements would probably be impossible. On the other hand the introduction of conventional control systems would compromise the low weight and simplicity of these vehicles. It should also not be forgotten that the one-man platforms so far developed are purely experimental and that there are still many problems, above all that of safety, that require careful study.

In other words, it will probably be quite some time before "flying platforms" swarm around like mosquitoes.

De Lackner Helicopters Inc.'s *Heli-Vector* uses two contra-rotating non-ducted rotors and resembles the N.A.C.A. rotor-powered vehicle in structure. The five floats (beneath the platform and on the arms) are also used as supports in land operations. The *Heli-Vector*'s control column has merely throttle lever, starter and rev. counter, and resembles motor cycle handlebars.



Fiumicino Intercontinental Airport

BY LIEUTENANT COLONEL GIUSEPPE AMICI, ROME

To supplement his earlier article on Fiumicino Airport in the October 1954 issue, the head of the competent Italian planning authority, Lieutenant Colonel Giuseppe Amici, of the Air Engineers Corps, now gives additional details of the design principles of this ambitious project, in the realization of which he plays a leading part. Situated about 12 miles to the southwest of Rome, near the seaside resort of Fiumicino on the Tyrrhenian Sea, the Eternal City's major airport will cover an area of roughly 2,500 acres. The approach to the three separate terminal buildings—international traffic, domestic traffic and government services—will alone be about six times as big as Saint Peter's Square in Rome, one of the largest (and most beautiful) squares in the world. Initially the airport will have only two runways intersecting at right angles, but the later addition of two more parallel runways is already planned. **Editors**

Bird's-eye view of Rome-Fiumicino Intercontinental Airport and surroundings, showing the ultimate arrangement of the airport (with four runways), the hexagonal Lago Traiano, the roads to Rome and the electric railway to Porta San Paolo.

Two thousand years of sand-storms and Tiber silt have slowly but surely buried the ancient harbour basin and buildings of the Imperial Roman port of Ostia. At the same time, however, they have wrested from the sea a strip of land on which the Eternal City's new intercontinental airport, as if to correct an error of history, is today being constructed.

Historical and topographical continuity from two ages have been combined into a single whole in the new airport: over the time-worn moles of the semi-circular outer harbour constructed by Emperor Claudius, a *heliport* (cf. 13) will be built, while Emperor Trajan's inner harbour of a later date—an exact hexagon still filled with water—will be made into an ornamental lake.

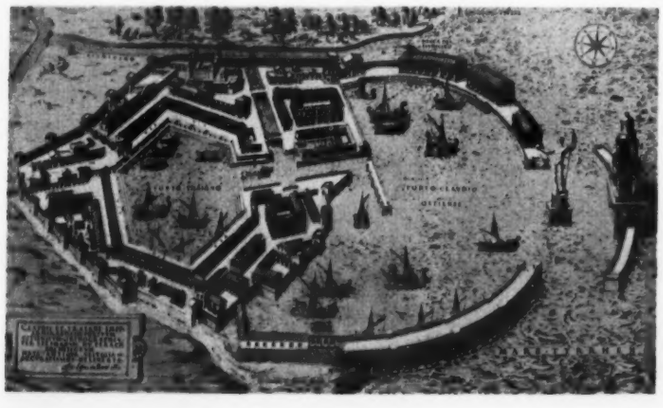
*

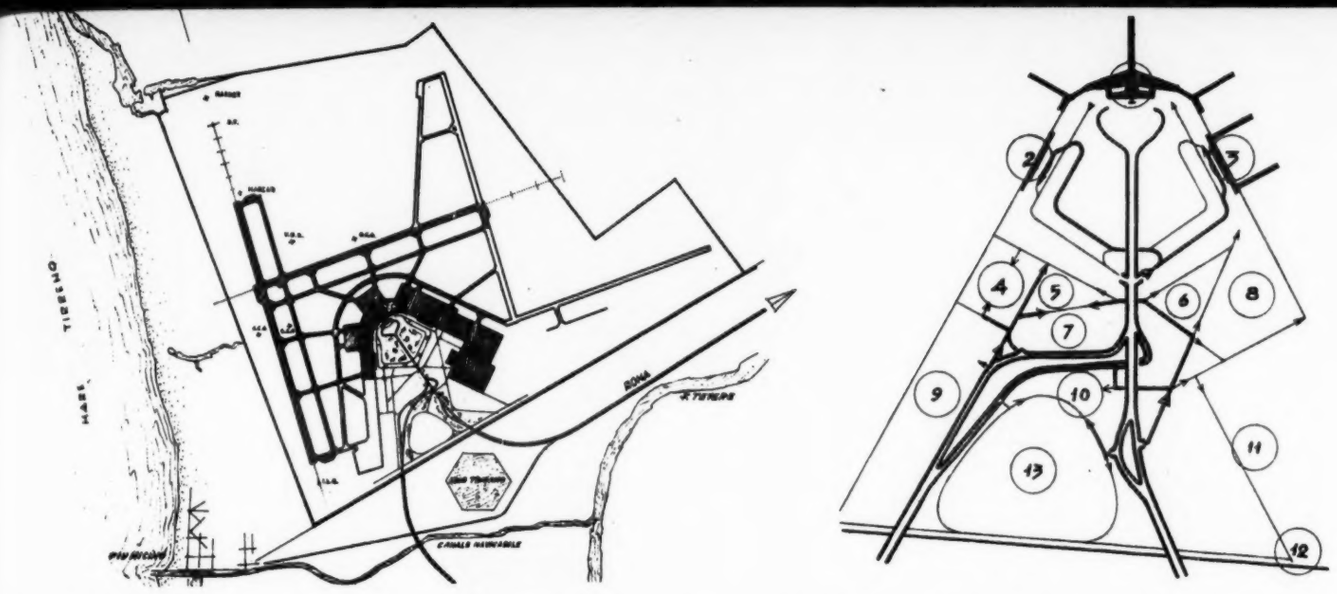
Being *completely free from obstructions* within a radius of 6 miles—beyond this distance there are a few hills on one side rising to about 260 ft.—the site seems an ideal one for a large modern airport. No other ground in the hilly Roman Campagna could offer such advantages. Moreover the airport is practically at *sea level,* and at some points even below it.

However, the high sand content of the ground—partly sea sand, partly silt, mixed with mud and clay—presented considerable difficulties in the matter of draining off rain water. The ground must therefore have an extensive drainage system and will have two pumping stations (total capacity 4,400 gals./min.).

The marked variation in wind direction necessitated the planning of two runways

Rome's ancient and modern ports: Left, the harbour of Ostia built by the Roman Emperors Claudius and Trajan (reconstruction by Stephanus Du Perach dating from 1575); right, the new airport being constructed on alluvial land, with heliport (over the old Porto Claudio) and ornamental lake (former Porto Traiano) with lawns.





Drawings of the airport terrain and the terminal installations at Fiumicino. The first (immediate) construction stage is shaded. 1 – terminal for international traffic; 2 – terminal for Government services and special duties; 3 – terminal for domestic traffic; 4 – fuel storage; 5 – barracks for customs and police officials and military personnel; 6 – auxiliary services; 7 – warehouse; 8 – bonded store; 9 – freight services; 10 – public amenities; 11 – technical services (overhaul shops etc.); 12 – railway station; 13 – heliport.

roughly at right angles. The 10,235-ft. *North-South* direction has been chosen for the *instrument runway*. Ultimately the main runways are to be duplicated. Meanwhile the taxiways (each 100 ft. wide, with a 33-ft. concrete strip on either side) parallel to the main runways (at a distance of 850 ft.) can also be used as runways during peak traffic periods.

The airport's electronic equipment will comprise an *ILS-3* instrument landing system (along the instrument runway), and a *Precision Approach Radar* system utilizable for either of the two main runways. There will also be a *Calvert-type approach lighting system* at the North end of the instrument runway and the East end of the second runway. A system of optical signals is planned for the control of movements on runways and tarmac.

*

It is not easy to forecast what will be the future traffic volume at Rome. A gradual *increase in international travel* and a rapid *increase in freight volume* can without doubt be expected. And if timetables and services on the Italian domestic network are improved, the increase in international traffic should also have a beneficial effect on domestic traffic volume.

From the outset, however, the presumably high percentage of transit traffic, the expected concentration of aircraft movements during peak hours of the day, and provision for special air services and official receptions, require a high degree of adaptability in the airport's ground installations. Then there are modern technical requirements to be met, such as hydrant fuelling system, water, air and power supply; baggage handling facilities; airline operations offices near the aircraft parking places etc.

Other aspects which had to be studied include the collection, transmission and distribution of *mail*, ensuring the shortest possible *distance* to be covered by passengers to and from the aircraft, the provision of comfortable *waiting rooms* for transit passengers etc. It was decided to build *three main terminals*, each capable of further expansion, for the following purposes: international traffic, domestic traffic, government services. A special zone for freight was also planned.—The design of the international terminal was described in *Interavia* No. 10, 1954.

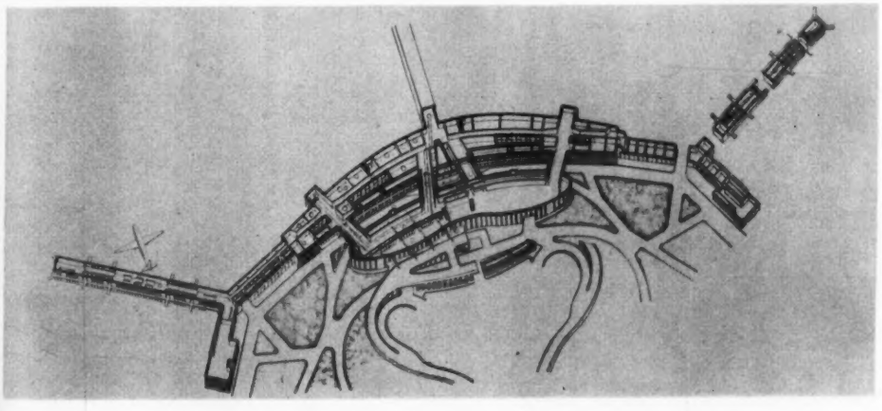
The general arrangement of the central installations can be seen from the accompanying drawing. Special attention may be called to the *centralization of the technical and public services* (in the centre of the characteristic triangle) and to the spacious heliport with its public amenities on a historic site (base of the triangle). A network of roads, designed to give absolute priority to the connecting lanes to the terminals, ensures ready access to all points, avoiding of course the customs authorities' "closed areas".

Roads to Rome are also to be improved and widened, so that travel time to the city centre should not exceed 30 minutes. One of the two roads should be of particular interest to tourists, as it passes Trajan's harbour basin, the ruins of *Ostia Antica* and its famous *Necropolis*.

*

Plans for Rome's intercontinental airport at Fiumicino are now complete. Further funds are to be made available, and work will continue uninterrupted, so that the new airport should be ready for service by 1958.

Drawing of the six-storey terminal for international traffic (with two-storey "fingers" leading to aircraft).



Reception on the Capitol (left to right): Georges Glasser, Amedeo Carassai, General Alfredo Bruno, Giuseppe Berretta, General Bonessa, Director Lars Brising, Signorina Bruno.

The European Idea is Gaining Ground

A.I.C.M.A.'s Fifth Annual Meeting in Rome (May 20th—21st, 1955)

The small group of men who met in Paris on April 28th, 1950, to found an international association of the Western European aircraft industry were courageous. At that time the industry in France and Italy was fighting for its existence, in Holland, Belgium and Spain it was either involved in painful reconstruction or was still in an embryonic state. And the very mention of a German aircraft industry was taboo. The only exception was perhaps Sweden who had created a relatively powerful industry during the war. Some of the six founding countries in 1950—Belgium, France, Holland, Italy, Norway and Spain—were only symbolic participants. But Georges Héreil, President of the French S.N.C.A. du Sud-Est, Peter Vos, the late Managing Director of Fokker, and Professor Guiseppe Gabrielli, the head of Fiat Aviation Division, succeeded in bringing the organization to life. Thus arose the *Association Internationale des Constructeurs de Matériel Aéronautique*, which held its fifth General Meeting in Rome on May 20th and 21st, 1955.

Héreil is today Honorary Chairman of the Association, Italy's General Bruno its present Chairman, and Professor Gabrielli the chairman of its technical committee. And the name of Peter Vos, as posthumous Honorary Chairman, will always remain connected with A.I.C.M.A., which now counts ten member countries: Belgium, Denmark, France, Germany, Holland, Italy, Norway, Spain, Sweden and Switzerland. It is, however, as Georges Héreil specifically stated at a dinner in Rome, still open to further membership. A.I.C.M.A. may expand still further and is well on the way to becoming a kind of peaceful balance to the Aircraft Industries Association of America and the Society of British Aircraft Constructors, both of which became more powerful during the war.

Today A.I.C.M.A. is neither an empty name nor a "luncheon club". Its achievements are already substantial. The standards committee has done useful and rewarding work for all its members; the research committee is preparing a common wind tunnel in Holland, to be available to all members, which is to be followed by others in France, Italy and perhaps elsewhere. The exchange of experience and licences entails constant consultation and will soon produce practical results and should lead to the restoration of a powerful European aircraft industry.

At the official banquet: two important guests, Admiral Emilio Ferreri (left), Chief of the Italian Admiralty Staff and head of Western European Union's Armament Office, and Signor Cristofini, his deputy.

Audience with the Pope.

Reception at the Italian Defence Ministry.

A.I.C.M.A. session (left to right): General Mazer, General Bonessa, P.A. Van de Velde, F.J.L. Diepen, W.I. Wicherlink, Maurice Heurteux, Georges Glasser, Henri Desbruères Professor Giuseppe Gabrielli, Gaston Thévenot, René Lucien, Tryggve Holm, Lars Brising, Fernand Vinsonneau, Jean Sévérac.

A visible expression of A.I.C.M.A.'s happy development in a brief five years was provided by the social events which accompanied—as is customary—the Rome meeting. The hosts, the Italian *Associazione Imprese Aeronautiche* headed by its Chairman General Alfredo Bruno, who is now serving his turn as head of A.I.C.M.A., were doubtless fortunate in their choice of Rome as meeting place. But the cachet borne by the meeting went far beyond the atmosphere of the Eternal City: there was a breath of Europe behind it . . .

It would be difficult to say what was the climax of the two-day event. The Mayor of Rome's reception on the Capitol, or the gathering at the Italian Defence Ministry, where uniforms were mixed among the dark suits? The most impressive ceremony was surely the delegates' audience with the Pope. In approving the Association's aims, in an address read in French, and calling for continued peaceful cooperation, the spiritual head of the Catholic world gave A.I.C.M.A. his apostolic blessing. An impressive moment even for non-Catholics.

A.I.C.M.A. Delegates in Rome

BELGIUM:
Emile Botte, Chairman of the Groupement Belge des Constructeurs de Matériel Aéronautique.

DENMARK: Not represented

FRANCE:
Georges Héreil, Honorary Chairman of the A.I.C.M.A. and President of S.N.C.A. du Sud-Est
André Granet, Secretary General of A.I.C.M.A.
Pierre Jaudon, legal adviser to A.I.C.M.A.
also:
Henri Desbruères (President, S.N.E.C.M.A.), Jean Gandilhon (Managing Director, Bréguet), Maurice Heurteux (Chairman of the Union Syndicale des Industries Aéronautiques, President of Messier), Jean Sévérac (Secretary General, S.N.C.A. du Sud-Ouest), Gaston Thévenot (Chairman, Syndicat des Equipements, and Director, Ets. Sadir-Carpentier), Fernand Vinsonneau (Chairman of A.I.C.M.A.'s standards committee and Technical Director, S.N.C.A. du Sud-Ouest), Raymond Wagrez (representing the Syndicat des Fabriquants d'Equipements, and Director, Ets. Jacottet), Engineer General M. Mazer (Air Ministry), Maurice Guilbot (Director, Union Syndicale des Industries Aéronautiques)

GERMANY:
Dr. L. S. Rothe, Chairman of the Bundesverband der Luftfahrtindustrie (Federal Aircraft Industries Association)

HOLLAND:
F.J.L. Diepen (Director, Fokker), P.A. Van de Velde (A.I.C.M.A. Treasurer, and Director, Aviolanda), W.H. Wicherlink (Foreign Relations Manager, Fokker)

ITALY:
General Alfredo Bruno (A.I.C.M.A. Chairman and Chairman, A.I.A.), Domenico Agusta (Managing Director, Agusta), Engineer Angelo Ambrosini (Board representative, S.A.I. Ambrosini), Giuseppe Berretta (Commercial Director, Fiat), Amedeo Carassai (Board representative, Aerfer), Agostino D. Derossi (Board representative Microtecnica), Paolo Foresio (President, Aeronautica Macchi), Professor Giuseppe Gabrielli (Technical Director, Fiat), Armando Piaggio (Vice-Chairman, A.I.A., and Board representative, Piaggio), Ricardo Campanini (Oleodinamica Magnaghi), Cesare Tonegutti (Technical Director, Alfa Romeo), Cesare Torazzi (Vice-Chairman, A.I.A., and Director, Fiat's Central Division), Emanuele Fraccon (Director, A.I.A.), General Enrico Bonessa (Inspector General of Technical Services, Air Ministry)

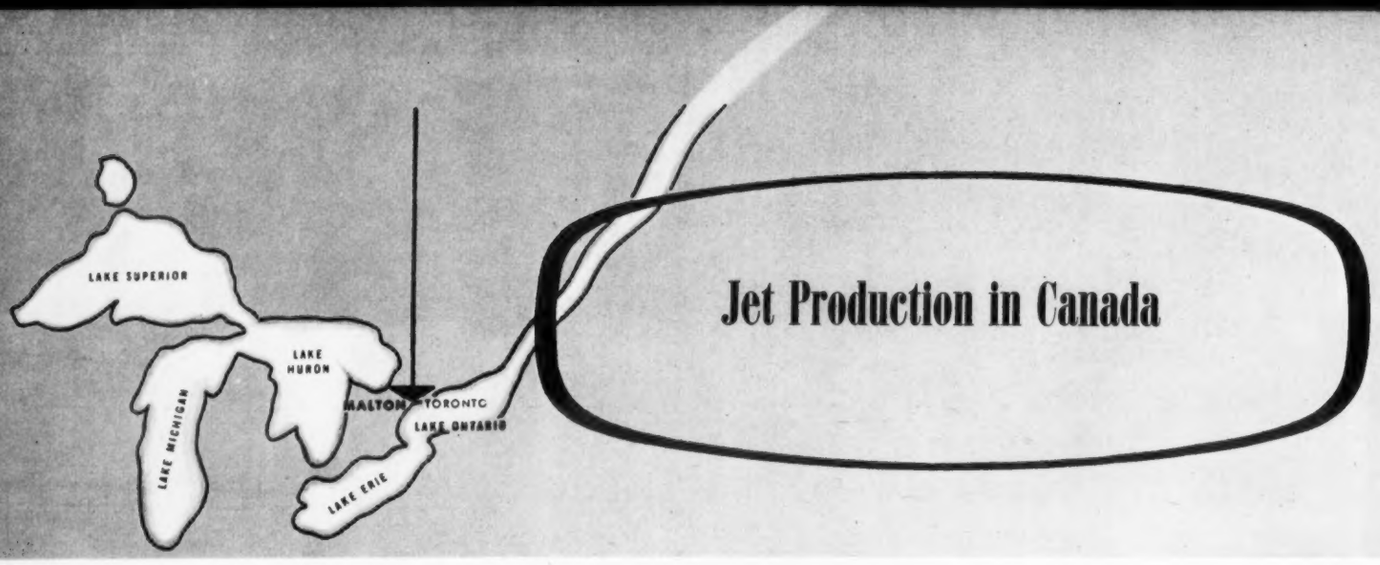
NORWAY: Not represented

SPAIN:
Pedro Huarte-Mendicoa (Chairman, A.T.E.C.M.A., Spain's aircraft industry association, and Director, CASA), Jorge Soriano (Secretary General, A.T.E.C.M.A.)

SWEDEN:
Tryggve Holm (Managing Director, Svenska Aeroplan A.B.), L. Brising (Technical Director, S.A.A.B.)

SWITZERLAND:
H.F. Alioth (Director, Pilatus Aircraft Works), Dr. Claudio Caroni (President, Flug- und Fahrzeugwerke Altenrhein), Charles Dechevrens (Chairman, Association Suisse de l'Industrie de l'Aviation).

A.I.C.M.A. session, the Committee (left to right): Emanuele Fraccon, Maurice Guilbot, André Granet, General Alfredo Bruno, Georges Héreil, General Mazer.



Jet Production in Canada

When the Canadian Government founded *Turbo Research Limited* shortly before the end of the war, nobody suspected that within a few years Canada would have a first-rate jet engine production plant. Whereas in 1946 there was not even the beginnings of an independent aero engine industry, Canada is now in a position to fit all day and all-weather fighters produced in the country (CF-100 and *Sabres*) with powerful jet engines of home design and production. This result speaks highly for the energy and organizing ability of Avro Canada's management and for the qualities of its engineers who, overcoming all difficulties, reached their target ahead of schedule.

*

In the spring of 1946 *A.V. Roe Canada Limited* took over all the plant and equipment of Turbo Research Ltd. at Leaside—under a programme for the transfer of all Government -owned arms plants to private ownership—and incorporated it in the main organization at Malton as the *Gas Turbine Division*. At first the new division concerned itself with continuing development work on the *Chinook* turbojet, design of which had been practically completed by Turbo Research. The prototype ran for the first time in March 1948 and after a number of improvements delivered a thrust of well over 3,000 lbs. However, before the first *Chinook* was completed, Avro Canada received a contract from the Royal Canadian Air Force for development of a high-power turbojet for the projected CF-100 *Canuck* all-weather fighter. This engine was named the *Orenda* and was to have a thrust of at least 6,000 lbs. for a dry weight of 2,500 lbs. After completing bench tests in February 1949 and receiving its certificate it was ordered into production by the R.C.A.F.

Production of the *Orenda* in a small pilot plant had not actually begun when the outbreak of the Korean war led the Canadian Government to erect a much larger production plant near the main installations at Malton. The foundation stone was laid in October 1950, and the new plant was ceremoniously opened by C. D. Howe, Canadian Minister of Defence Production, on December 29th, 1952. A brief eighteen months after the inauguration of the new facilities the thousandth *Orenda* engine was delivered. After small batches of the *Orenda 8* and *Orenda 10* had been completed, production of an improved version, the *Orenda 11*, with two-stage turbine and increased thrust, was begun early in 1954. Today another development, the *Orenda 14*, with more than 6,500 lbs. s.t., is also in production.

At the end of 1954 the Canadian branch of the Hawker Siddeley Group was reorganized, and Avro Canada's Gas Turbine Division made into an independent subsidiary. This firm is named *Orenda Engines Limited* and employs at present more than 6,000 persons.

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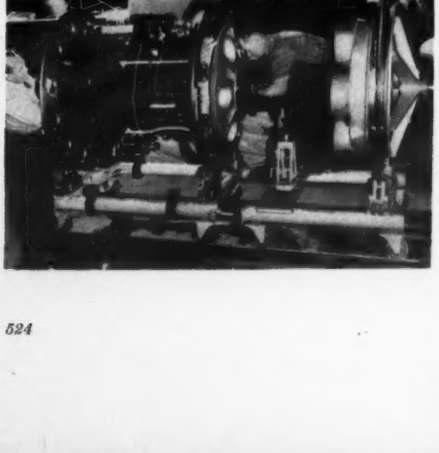
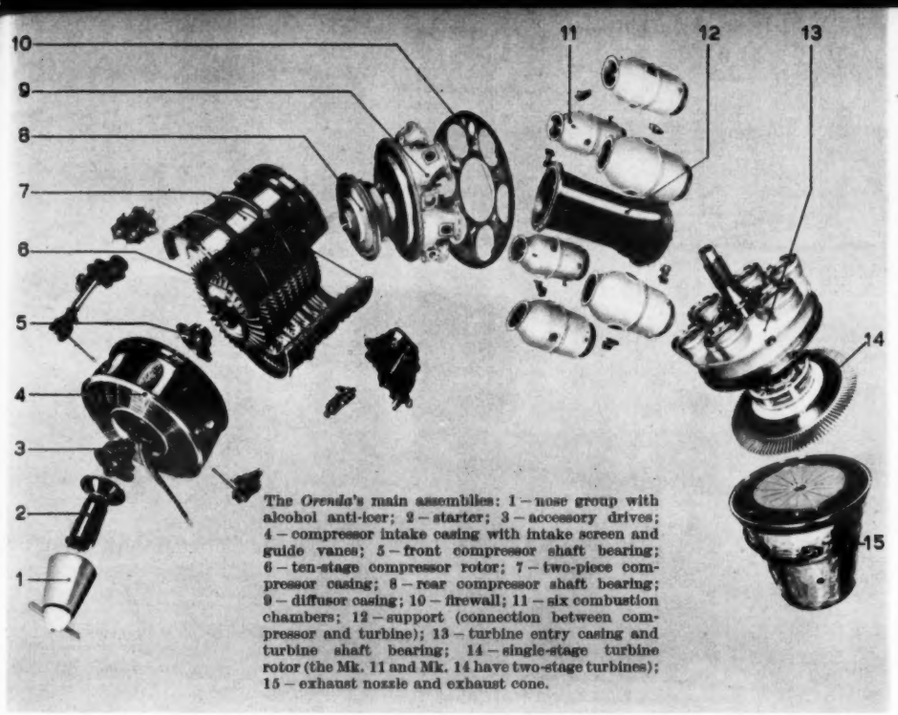
Some idea of the difficulties which had to be overcome before jet engine production could get under way in Canada was recently

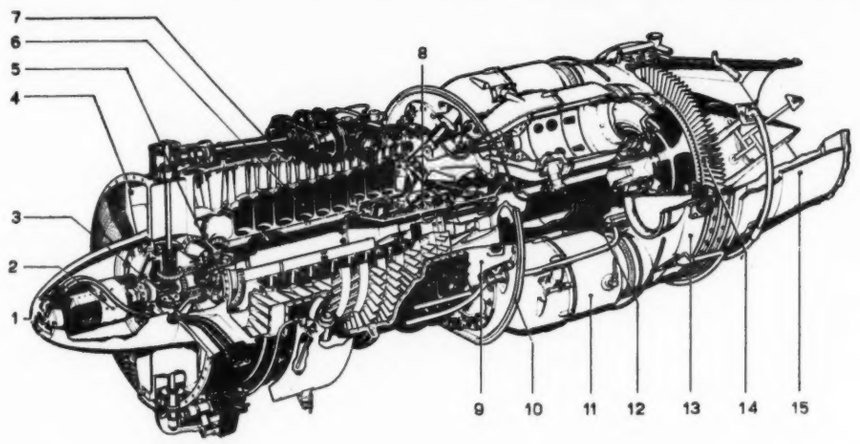
The *Orenda* is assembled on horizontal drums, which are moved on rails from one production station to the next.



One of the most costly processes is milling out the annular slots in the compressor casing and fitting the 2,000 odd stator blades (left). Another lengthy operation is machining the ten-stage compressor rotor (right).



The *Orenda's* main assemblies: 1 – nose group with alcohol anti-icer; 2 – starter; 3 – accessory drives; 4 – compressor intake casing with intake screen and guide vanes; 5 – front compressor shaft bearing; 6 – ten-stage compressor rotor; 7 – two-piece compressor casing; 8 – rear compressor shaft bearing; 9 – diffusor casing; 10 – firewall; 11 – six combustion chambers; 12 – support (connection between compressor and turbine); 13 – turbine entry casing and turbine shaft bearing; 14 – single-stage turbine rotor (the Mk. 11 and Mk. 14 have two-stage turbines); 15 – exhaust nozzle and exhaust cone.



given by E. K. Brownridge, Vice-President Manufacturing of Orenda Engines Ltd., in a lecture to the Canadian Aeronautical Institute. One major problem was finding skilled workers with experience of complex modern machine tools. In January 1952, before the new Malton plant was taken over, there were only 200 skilled workers in engine production, but the number required rose by more than 500% within a single year. During the same period the amount of material required increased by 1,200%, which meant an increase in monthly procurement costs from $ 500,000 to over $ 6,000,000. In addition, there were at the time few firms in Canada able to supply raw materials or parts in sufficient quantity and of the necessary quality. Hence work had to be subcontracted to a number of firms in Britain and the United States, some of which set up new works in Canada specially for the purpose.

Passing on to development and production problems, Brownridge mentioned a number of difficulties which other gas turbine manufacturers also have had to tackle. Because of rapid technological progress, the Malton plant had constantly to deal with modifications to engine types already in production. To enable the engine to go into large-scale production before it became obsolescent, the *Orenda* was designed from the start, in close collaboration with the production department, so that subsequent modifications could be made without appreciably delaying delivery dates. Here it should be mentioned that incorporation of a two-stage turbine in no way slowed down production. To enable modifications to be made during the production stage, work preparation and tooling must be organized so as to be rapidly changed. Avro Canada therefore decided that it would not be expedient to introduce too high a degree of automatic operation into the various production processes. For example, the *Orenda* comprises more than 3,500 sub-assemblies with over 16,000 individual parts, more than 4,000 of which have been modified during recent years.

In particular it was found that maintenance of the prescribed tolerances was one of the major production problems. In gas turbine construction all materials used—from ultra-light magnesium to heat-resistant steel—must be worked with an accuracy in no way inferior to that required in precision engineering. If, for example, in the *Orenda* the clearance between turbine blade tips and turbine casing is only 0.001 inches too great, there will be a loss in thrust of 15 lbs.

Another important question was to determine which parts should be produced on a "line" basis and which on a "batch" basis. It was finally decided that, with few exceptions, all larger and more complicated parts should be tooled up on a "line", while smaller, simpler ones, such as shafts and drums, should be produced in batches. The advantage of "line" production is that flow time through the shop can be shortened. In other words, the number of parts handled by a machine in a given time can be raised and work volume in process reduced.

In both the experimental plant taken over from Turbo Research and the pilot plant at Malton, the first *Orenda* engines were assembled in vertical stands. In the new plant, however, it was decided to plan for horizontal assembly, each engine proceeding from station to station along the line on a drum-shaped fixture. With this arrangement all work can be carried out at floor level. Another advantage is that parts need no longer be directed to many different points on the assembly floor.

*

From drawing board to quantity production, the *Orenda's* development period was roughly seven years. Today, however, Brownridge states, a new jet engine could be developed in only five years, as Orenda Engines Ltd.'s production facilities and labour force are now equal to any task.

The Canadian engine firm is now working on a turbojet for over 10,000 lbs. thrust. It also is planning production of a smaller jet engine to power a new R.C.A.F. trainer.

What's in the Air?*

AVIATION POLITICS

• U.S.-British Arctic negotiations

Britain and the United States are close to signing an agreement enabling British and American airlines to fly between the U.S. West Coast and England over the Polar route, according to Sir George Cribbett, Deputy Secretary of the Ministry of Transport and Civil Aviation. The signature of an agreement, however, would not necessarily mean that British and American carriers would start the service immediately, since British Overseas Airways Corporation would have to await delivery of "new-type long-range propeller-turbine transports" (i.e., the Bristol *Britannia*).—However, as B.O.A.C. has also ordered ten Douglas DC-7Cs, which are scheduled for delivery in the last quarter of 1956, it would seem that a British trans-Arctic service to West Coast points could be opened earlier.

• Germany applies for I.C.A.O. membership

The Tenth General Assembly of the International Civil Aviation Organization in Montreal has received an application for membership from the West German Federal Republic. Before membership can be granted the following conditions will have to be met: the application must be approved by a $^4/_5$ majority of the countries represented at the General Assembly; it must be approved by the General Assembly of the United Nations; and each of the countries which fought against Germany in World War II must agree.

SERVICE AVIATION

• Boeing B-52 production speed-up

After a secret session with the Senate Armed Services Committee, Air Force Secretary Harold E. Talbott stated that production rate of the Boeing B-52 eight-jet strategic bomber will be stepped up by 35% to enable the U.S. Air Force to replace its Convair B-36s "well ahead of the present schedule". Unofficial estimates are that a year will be shaved off from earlier schedules for procurement of a B-52 striking force of about 500 aircraft, meaning that the fleet would be complete by 1958. For this programme the Air Force plans to ask the Congress for more than $300,000,000 in extra appropriations.—Apparently the Pentagon is still discussing whether a similar speed-up should be made in production of the North American F-100 *Super Sabre* supersonic fighter, the Convair F-102 delta fighter and the McDonnell F-101 *Voodoo* long-range bomber-escort fighter.

Captain Roy L. Johnson, U.S. Navy, has been appointed prospective Commanding Officer of the aircraft carrier *Forrestal*, now under construction. Picture shows him holding a model of the *Forrestal*.

• New S.A.C. Chief of Staff

In a surprise move General Curtis E. LeMay, Commander-in-Chief of the U.S. Air Force's Strategic Air Command, has replaced his Chief-of-Staff General R. M. Montgomery by Brigadier General Jack Roberts.

Igor Sikorsky, Engineering Manager, Sikorsky Aircraft Division of United Aircraft Corporation, paid a visit to D. Napier & Sons, London. Left to right: J.B. Waite (Napier Aero Sales Manager), J.D. Robinson (United Aircraft Export Corporation), A.J. Penn (Chief Engineer, Aero Gas Turbine Division, Napier), J.S. Paget (Napier General Manager), Igor Sikorsky, H. Sammons (Napier Managing Director).

In the re-organization of the Air France management the following appointments were announced: Michel de Villeneuve to Commercial Director, Emile Delclaux to Financial Director, Auguste Vivier to head of the Flying Equipment Department.

AIR TRANSPORTATION

• European air transport needs new short-range aircraft

At the Annual General Meeting of the German Commercial Airports Cooperative (Arbeitsgemeinschaft Deutscher Verkehrsflughäfen), which dealt primarily with the economy of commercial airports and, indirectly, of commercial air services, the provision of a transport aircraft for short-range European services was described as extremely urgent. Under-Secretary of State Brandt (North Rhine-Westphalia) stressed that 56 short-range services involving distances of up to 310 miles are flown at present in Europe and that this number would increase if adequate flying equipment were available. An "ideal" aircraft of this type for short-range runs ought to have the following characteristics: accommodation for 15 to 20 passengers, cruising speed of approximately 190 m.p.h., independence of meteorological conditions and a small wing loading in order to simplify ground facilities. A light twin-engined aircraft was recommended.

• S.A.S. pilot walk-out averted

A total of 73 co-pilots of Swedish nationality, who had threatened Scandinavian Airlines System to cease work and cancel their contracts, have accepted the proposal of the Supreme Mediation Board after eleventh hour negotiations. —The conflict was due to the fact that Swedish co-pilots felt themselves to be at a disadvantage in the system of promotions applied by the Scandinavian airline (three-sevenths Swedes, two-sevenths Danes, two-sevenths Norwegians). Under the new agreement, which is valid until 1960. Captains will in future be appointed on personal qualifications, regardless of nationality.

• Air France orders L-1649A Super Constellations

The Board of Air France has decided, subject to French Government approval, to place an order for twelve Lockheed L-1649A *Super Constellations*. Deliveries are expected to begin in the spring of 1957.

• Sixty million dollar loan for P.A.A. fleet

Pan American World Airways has concluded a twenty-five-year $60,000,000 financing arrangement with a group of 18 insurance companies, Company President Juan T. Trippe told the Annual General Meeting. The new credit will carry a $3\frac{3}{4}$% interest rate and will be used to finance new aircraft purchases. At present P.A.A. has Douglas aircraft on order to a total value of $110,000,000 (33 DC-7Cs and 7 DC-7Bs), compared with $68,000,000 a year ago.—On the subject of the *Comet 3s*, Trippe said that "because of changes in the *Comet* picture," Pan American had at present no commitment to purchase de Havilland aircraft.

INDUSTRY

• The U.S.A.F. disapproves . . .

. . . of Boeing plans to bring out the long-promised civil version of the KC-135 (707). This attitude has caused some surprise amongst Boeing executives. They insist that the Air Force has no claim upon the Model 707 jet transport prototype "which was privately built". The only question is whether the firm can use KC-135 basic tooling for concurrent civil manufacture.

• Sperry-Rand merger completed

The merger between Sperry Corp., of New York —one of the leading U.S. electronic firms—and Remington Rand Inc. has been approved at general meetings of both companies. Chairman of the Board of the new Sperry Rand Corp. will be General Douglas MacArthur, and President will be Harry Vickers.

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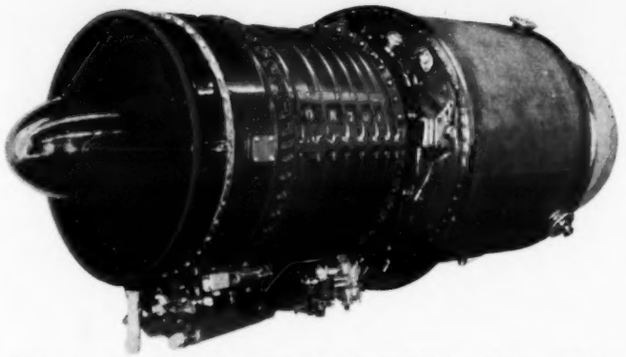
* Extract from *Interavia Air Letter*, daily international news digest in English, French and German. All rights reserved.



A 150-hour type test of the Bristol *Orpheus* light turbojet produced a thrust of 3,285 lbs. The *Orpheus* is to be fitted in the Folland *Gnat*, Fiat G.91, Bréguet *Taon* and Dassault *Mystère 26*.

First transition flights from helicopter to fixed-wing operation have been made by a *McDonnell XV-1* convertiplane. The four-seat XV-1 is an experimental model and may become the fore-runner to a larger troop and freight transport.

• United-Marquardt merger plan abandoned

Marquardt Aircraft Co., Van Nuys, California, manufacturers of ramjet engines etc., have told stockholders that discussions on a possible merger with United Aircraft Corp. were broken off at an early stage and will not be pursued.

• Rome supersonic wind tunnel inaugurated

The Aeronautical Engineering School of the University of Rome (Professor Luigi Broglio) has officially inaugurated its new supersonic wind tunnel. The ceremony was attended by high civil and military personalities and a delegation of foreign scientists, and the wind tunnel was blessed by Cardinal Colso Constantini. Later Professor Theodore von Karman, member of the Papal Academy and Chairman of N.A.T.O.'s Advisory Group for Aeronautical Research and Development, read a speech on the problems of supersonic speeds.

• Fokker increases net profit

Royal Dutch Aircraft Works Fokker reports a considerable expansion of activities and a significant improvement in financial results for 1954. Net profit for the year was 298,951 guilders, compared with 231,171 guilders in the previous year and 169,898 guilders in 1952. The Board recommended payment of a dividend of 10% (8% in 1953) on ordinary shares.

FLYING EQUIPMENT

• It is believed in United States aviation circles that American Airlines will shortly announce an order for a new *medium-range turbo-prop commercial transport*, probably before these lines appear in print. Douglas and Lockheed designs are said to be the chief rivals. The most likely engine is the Allison 501-D10 of 3,750 e.h.p.

• *Lockheed Aircraft Corp.* has for the first time released details of its *L-1649A Super Constellation* long-range airliner: fitted with four 3,400 h.p. Wright R-3350-EA2 compound engines.—Span 150 ft., wing area 1,850 sq.ft., gross weight 156,000 lbs., max. space-limited payload 17,000 lbs. up to ranges of 4,700 miles, or 16,000 lbs. over 5,000 miles.—Compared with earlier versions of the *Super Constellation* the L-1649A has a completely new wing unit with not only larger span and area but also smaller thickness/chord ratio and more effective landing flaps. Anticipated performance figures are a top speed in excess of 400 m.p.h. and a max. cruising speed around 350 m.p.h. With a fuel supply of 9,600 U.S. gals., range is more than 6,500 miles.—The first L-1649A will go into commercial service in 1957.

• *The Douglas DC-7B* four-engined long-range commercial transport has been awarded its Certificate of Airworthiness. First deliveries to P.A.A. and Eastern Air Lines were made at the beginning of June.—Douglas Aircraft also announces that construction of the first DC-7C is progressing according to schedule; fuselage assembly began early in June; assembly of wing unit and fuselage of the first of 87 DC-7Cs so far ordered should be complete by the beginning of November, and the first flight made before the end of the year.

• On the evening of May 27th *S.N.C.A. du Sud-Est's SE.210 Caravelle* twin-jet medium-stage commercial transport made its first flight at Toulouse, with Pierre Nadot, head of S.N.C.A.S.E.'s flight test division at the controls.

• *SIPA 1000 Coccinelle* is the name of a light two-seater developed by Engineer Yves Gardan, which has an empty weight of only 660 lbs. and consumes no more than 33 m.p.g. Max. speed is given as 125 m.p.h. and cruising speed as 112 m.p.h.; range 370 miles; ceiling 16,000 ft.—Production costs for quantity production 1,200,000 francs, but this figure would be reduced to 400,000 francs with the system of Government subsidies for the purchase of private aircraft.—Power plant in the *Coccinelle* is a 65 h.p. or 90 h.p. Continental.

POWER PLANT

• The following *overhaul periods* for some of its more usual jet engines are announced by the U.S. Air Force: General Electric J-47-GE-17 and GE-33: 225 hours; General Electric J-47-GE-25: 625 hours; Wright J-65-W-5: 125 hours.

• Thrusts of more than 10,000 lbs. have been measured during a 150-hour test run on the *Allison J-71-A-11* axial-compressor turbojet. The J-71, the most powerful turbojet at present being built by Allison, measures 191.4 ins. in length, without afterburner, and 39.5 ins. in diameter.—It is fitted in the Douglas B-66 and RB-66 twin-jet bomber and reconnaissance aircraft, the McDonnell F3H Navy fighter and the Martin XP6M *Sea Master* flying boat.

• *The Rolls-Royce RB.109* two-spool turboprop engine is making test runs at Derby.

• *The Bristol Orpheus* light turbojet destined for the Folland *Gnat*, Fiat G.91, Bréguet *Taon*, Dassault *Mystère 26* etc., has satisfactorily completed a 150-hour test run. Thrust measured for this initial version of the *Orpheus* is 3,285 lbs.; thrust/weight ratio 4.4. Other versions under development are already running at higher powers (e. g. for the production *Gnat*).

• A new more efficient *S.N.E.C.M.A. jet deflection device* has been tested in a D. H. *Vampire*. The four-ton aircraft came to a standstill in 295 yds. after landing, whereas without deflector it would have a landing run of 765 to 875 yds. using wheel brakes only. Without wheel brakes but with deflector, landing distance is approx. 610 yds.

• *Curtiss-Wright* is now producing 250 turbojets of the J-65 type per month.

Beginning of production of the *Fokker F.27 Friendship* by Fairchild, United States, may be speeded up following President Eisenhower's signing of the Bill granting permanent operating certificates to the U.S.A.'s fourteen local service carriers. The 28/36-passenger transport (two R.-R *Dart* turboprops of 1,540 h.p. plus 365 lbs. residual thrust), for which Fokker and Fairchild have concluded a joint production agreement, is regarded as ideal for handling traffic on local service and feeder carrier routes in the United States.

Star performer at "ILSY 5" was Fokker Chief Test Pilot Gerben Sonderman who first ferried the Dutch Royal Family to Ypenburg aboard a Douglas DC-3, then demonstrated the Fokker S.14 *Machtrainer* and a Fokker-built *Hunter* fighter. This picture shows him in the *Machtrainer*.

Flight-Lieutenant W.N. Peterson, R.C.A.F., climbing into the cockpit of the Canadair-built, *Orenda*-powered *Sabre 5* fighter he demonstrated at ILSY 5.

Fokker Chief Test Pilot Sonderman in the cockpit of a *Hunter* fighter.

"ILSY 5"

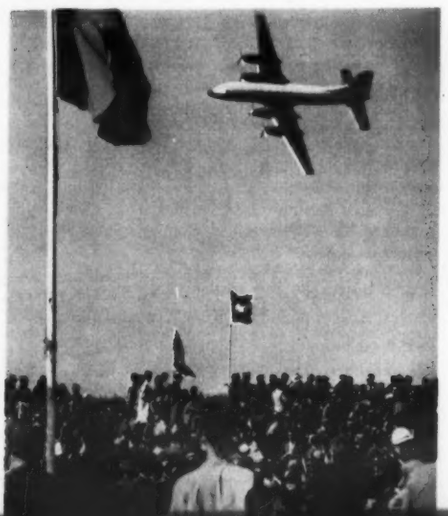
More than 200,000 spectators—among them Queen Juliana and Prince Bernhard of the Netherlands—assembled at Ypenburg aerodrome near The Hague on May 30th to watch the Fifth *Internationale Luchtvaartshow Ypenburg* (ILSY). The event was particularly impressive this year and was staged in the light of the 50th Anniversary of the *Fédération Aéronautique Internationale*.

"ILSY 5" followed the present general trend of Western European air displays: to a certain extent it was a N.A.T.O. show. Military pilots from the U.S.A., Canada, Great Britain, Rhodesia, France, Italy, Belgium and Holland demonstrated their prowess, individually and in formation, aboard the latest equipment of their air forces. Western European manufacturers showed some of their recent military and civil products, no doubt with an eye on the potential N.A.T.O. market as well as in the hope of attracting commercial buyers.

A catalogue of aircraft demonstrated would include the following types: North American F-86D *Sabre,* Canadair-built *Orenda*-powered F-86 *Sabre*, Republic F-84 *Thunderjet*, Hawker *Hunter* and Fokker-built *Hunter,* Hawker *Seahawk, Venom*, Gloster *Meteor* and Dassault MD.450 *Ouragan* fighters; Boeing B-47 *Stratojet* bombers; Fokker S.14 *Machtrainer* jet trainers; S.N.C.A.N. 2501 *Noratlas* and Bristol *Britannia* transports; S.N.C.A.S.O. 1221 *Djinn*, Hiller, Sikorsky S-55 and Bell 47 helicopters. Light relief was provided by British World War I fighters in mock dogfights, as well as by a bevy of French, Yugoslav and Turkish parachutists—including a group of intrepid young ladies.

The Dutch Royal Family watches a flight of Hawker *Seahawks* of the British Royal Navy.

The Bristol *Britannia* flies past.



The pilots of the R.A.F. *Hunter* aerobatic flight.

Flag parade by Turkish, Yugoslav and Dutch girl parachutists.

The Air Transport Association's "Facts and Figures" for 1954

No headaches for A.T.A.

" RECORD OF INCREASING USEFULNESS " is written in white letters on the cover of " Air Transport Facts and Figures " for the 1954 calendar year published by the Air Transport Association of America.

" In those nine years " (since the war), writes A.T.A. President Earl D. Johnson * in his introduction, " the scheduled airlines, in terms of service performed, that is, revenue ton miles flown, have almost tripled their usefulness to the country... The airlift capacity of the Civil Reserve Air Fleet is approximately ten times that of the civil air fleet that undertook military transport services with such distinction during World War II... The cost for supplies and equipment is at least between three and four times what it was in 1939. The wage level is 2.2 times as high. The Federal income taxes levied upon them are 24 times what they were in 1939. And the airlines, since December 31st, 1945, have invested over 850 million dollars in the new equipment and related facilities necessary to expand the industry's ability to serve."

And the A.T.A. President supplements his success report with the brief remark, " *In fact, the domestic trunkline system... is virtually one hundred per cent free of subsidy.*"

All this creates the impression that U.S. air transport has no present worries. — In fact business is by no means bad and is a good deal better than during the critical period following the Korean boom two years ago, when balance sheets had a somewhat " mangled " appearance.

In contrast to the 1953 business year, revenue on scheduled domestic services increased more than expenditure last year. Overseas services also made a fairly good showing in this respect. Nevertheless responsible airline officials realize that there are still problems ahead.

The language of figures

Out of a total of 1,675 air transport undertakings in the United States, the A.T.A. figures cover only 59, operating regular services as follows : 13 domestic trunk lines ; 14 domestic local service lines ; 10 international and overseas lines ; 14 territorial lines (Alaska, Hawaii, etc.) ; 5 all-cargo lines ; 3 helicopter airmail lines. However these 59 airlines handle such a large percentage of the total traffic volume that the 1,616 companies not certificated for scheduled traffic (irregulars, air taxi operators etc.) can be practically ignored.

Scheduled airlines exceeded the 35,000,000 passenger mark for the first time in 1954 ; this is nearly three times as many as the number recorded for 1946 (a striking fact is that the U.S. international airlines provided only 10 % of this result).

In order not to overload this brief account of U.S. air transport, no more tables (aircraft miles, passenger-miles, freight or mail volume) will be included. Details of the above passenger figures are given because they provide a graphic picture of the position held by U.S. airlines in world air transport. According to International Civil Aviation Organization figures, a total of 58,000,000 passengers was carried by the world's airlines in 1954 (excluding U.S.S.R. and China). In other words, the United States handles 61 % of total world passenger volume—sufficient reason for non-Americans to give increased attention to U.S. air transport questions.

*

Basically speaking, all U.S. air transport's problems can be reduced to the brief formula : *Government agencies appear to be doing everything in their power drastically to cut down the airlines' profit margin, while a variety of factors combine to create a constant increase in costs.* Having been treated as the nation's pet " baby " during its early years, the American air transport industry is now evidently considered adult enough to stand in its own feet. The official attitude is all the more disturbing in that the airlines' profit margin even now can scarcely be called princely. In 1954 the industry quoted an operating revenue totalling $1,411,570,000 out of which, after taxation amounting to $73,370,000, it drew a net profit of $69,180,000. There can be few industries in the United States that have to work on so small a margin (though in some cases the airlines' depreciation policy is not clear).

Profit possibilities shrinking

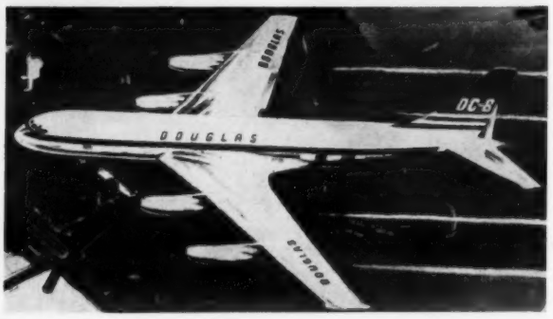
Since 1951 a clear distinction has been made in the United States between subsides and mail pay. The appropriations for airline

* Since the publication of " Facts and Figures " Johnson has announced his resignation from the A.T.A. Presidency to take up the post of Senior Vice-President for Development and Operation, General Dynamics Corp.

Passengers (in thousands) carried on U.S. scheduled services

Year	1946	1947	1948	1949	1950	1951	1952	1953	1954
Domestic trunk	11,890	12,279	12,324	14,021	15,978	20,621	22,759	26,137	29,347
International	1,041	1,360	1,373	1,520	1,675	2,033	2,362	2,682	2,851
Local services and territorial	324	612	844	1.060	1,446	2,031	2,251	2,585	2.986
Total	13,255	14,251	14,541	16,601	19,099	24,685	27,372	31.404	35,184

Left : Lockheed L-1049 G *Super Constellation* with auxiliary fuel tanks at the wing tips for a maximum range of 5,840 miles (without reserves).



Right : Drawing of the Douglas DC-8 jet transport, production of which has now been definitely decided. Power plant consists of four advanced versions of the Pratt & Whitney J-57.

subsidies have been reduced from year to year and today have reached almost negligible proportions. For example, the total awarded in 1954-55 was $73,052,000 (a bare 5 % of the airline industry's total operating revenue), and for 1955-56 C.A.B. has proposed that the original estimate of $79,100,000 be cut to $61,698,000.

*

Not only are the airlines now operating practically without subsidy, but there has also recently been a move by C.A.B. to reduce pure *airmail rates.* For example, it was decided at the end of 1954 to halve mail pay to the two Atlantic airlines Trans World Airlines and Pan American Airways, contrary to the recommendation of the C.A.B. examiner. T.W.A. was granted only $4,281,000 for mail in 1954, instead of $8,507,000, and P.A.A. got $8,151,000 instead of $15,915,000. Though P.A.A. has protested to C.A.B. against this decision, it may be assumed that the airlines will in future have to accept the fact of reduced mail pay. The change in top C.A.B. officials made in June 1955 (new Chairman Ross Rizley) is unlikely to mean any basic modification in policy.

*

Another example of the present trend towards economy at the expense of the air transport industry is provided by the rates that have been fixed for the new *experiment of carrying normal letter mail by air without extra charge.* Since October 1st, 1953, the Post Office has been sending ordinary 3-cent mail by air on a number of routes in the Eastern and Western States. This experiment—incidentally a thorn in the flesh to the U.S. railroads—reached considerable proportions within its first year. By October 1st, 1954, a total of 9,600,000 ton-miles had been flown, saving roughly 10,000,000,000 hours.

But what about payment ? Whereas the Post Office received mail fees of $29,500,000 from the experiment, it paid only $1,830,000 to the airlines involved and put 94 % into its own pocket.

*

Whether in the matter of taxation and other charges or the insistence on uncomfortably low rates, the Government has made it plain all along the line that it no longer intends to " pamper " air transport. This attitude is expressed fairly openly in the inter-ministerial Transport Report submitted to President Eisenhower early in February 1955 (more liberal treatment of the railroads, lower Government aid for other branches of transport, a freer hand for shipping companies actively to participate in overseas air transport).

Rising costs

Despite the care and energy which the airlines gave to controlling their costs in 1954, there are unmistakable signs pointing to a further increase in the future.

To judge by the experience of 1954, the whole question of *salaries* appears to be coming to the fore again ; at any rate the summer of 1954 brought several leading airlines face to face with labour demands which were frequently difficult to settle. For example, American Airlines, strike-bound for a whole month, added more than $12,000,000 to its payroll, thus losing more than 5 % of its revenue for the year.

*

Another headache is the still unsolved problem of *cancelled reservations.* In March 1955 ten airlines operating tourist services advocated the re-introduction of the system of " fines ", proposing that passengers failing to cancel reservations within three hours of departure time should be charged 20 % of the fare.

Again, the long-term effect on airline balance sheets of cheaper tourist-class rates—A.T.A. states that in 1954 they were used on 32.7 % of all domestic flights and 52.3 % of overseas flights—is still not clear. One interesting development, however, was Western Air Lines' resumption of " The Californian " super-luxury service, with a return to free champagne, orchids and cigars (incidentally, every woman passenger on " The Californian " is now also presented before landing with a small bottle of French " Carnet de Bal " perfume). Several other domestic airlines seem to be contemplating following Western's example, an indication of the industry's distrust of the cut-price method of attracting passengers.—The same applies to the " pay later " scheme ; though it is at present enjoying considerable popularity, its effects on the balance sheet are still in doubt.

*

However, the cost-increasing factors so far mentioned pale into insignificance before the central problem which the U.S. air transport industry will have to tackle in the next few years, that of renewing its fleets.

The jet transport is on the threshold

In March 1955 A.T.A. President Earl D. Johnson told an audience in Los Angeles that in his opinion the air transport industry must be prepared to spend around $1,500,000,000 on fleet renewal during the coming decade.

At that time the question still did not appear to be an urgent one. True, Lockheed was preparing a turboprop version of the *Super Constellation,* Douglas a similar version of the DC-7 and both firms were working on turboprop transports for medium stages ; but the most delicate problem, that of the pure jet transport, did not then appear to need immediate attention. The Boeing 707 was flying—but for the U.S. Air Force, and the Pentagon seemed to be distinctly unfavourable to the production of the long-announced civil version.

But the situation has changed fundamentally within the last few days.

On June 7th Donald W. Douglas, President of Douglas Aircraft Company, announced to a Board meeting that his company had decided to *begin production of the long-planned DC-8 jet transport.* Needless to say, the announcement was not made until technical details of the project had been settled and its market prospects assessed. Powered by four turbojets of an advanced version of the Pratt & Whitney J-57, the DC-8 is to have a speed of more than 550 m.p.h. and be capable of carrying 80 first-class or 125 tourist-class passengers across the Atlantic (New York to Paris) in less than seven hours (gross weight of over-water version 257,000 lbs., of domestic version 211,000 lbs., span 134.6 ft., length 140.6 ft., height 40.2 ft.)

As regards turboprop transports, C.R. Smith, President of American Airlines, also announced on June 7th that his firm has awarded Lockheed an " initial contract " for 35 four-engined turboprop aircraft for use on its medium-haul services.—Named *Electra* to commemorate Lockheed's first all-metal aircraft, the new model for 65 to 90 passengers is designed for maximum flexibility, as it is to be capable of operating over ranges of from 150 to 2,000 miles. No final decision has yet been made on the power plant, to be used (four propeller turbines), as the *Electra* can apparently take engines of higher power than the Allison 501-D 10 (civil version of the T-56) originally envisaged. (Span 95 ft., length 101 ft. 4 ins., height 34 ft.).

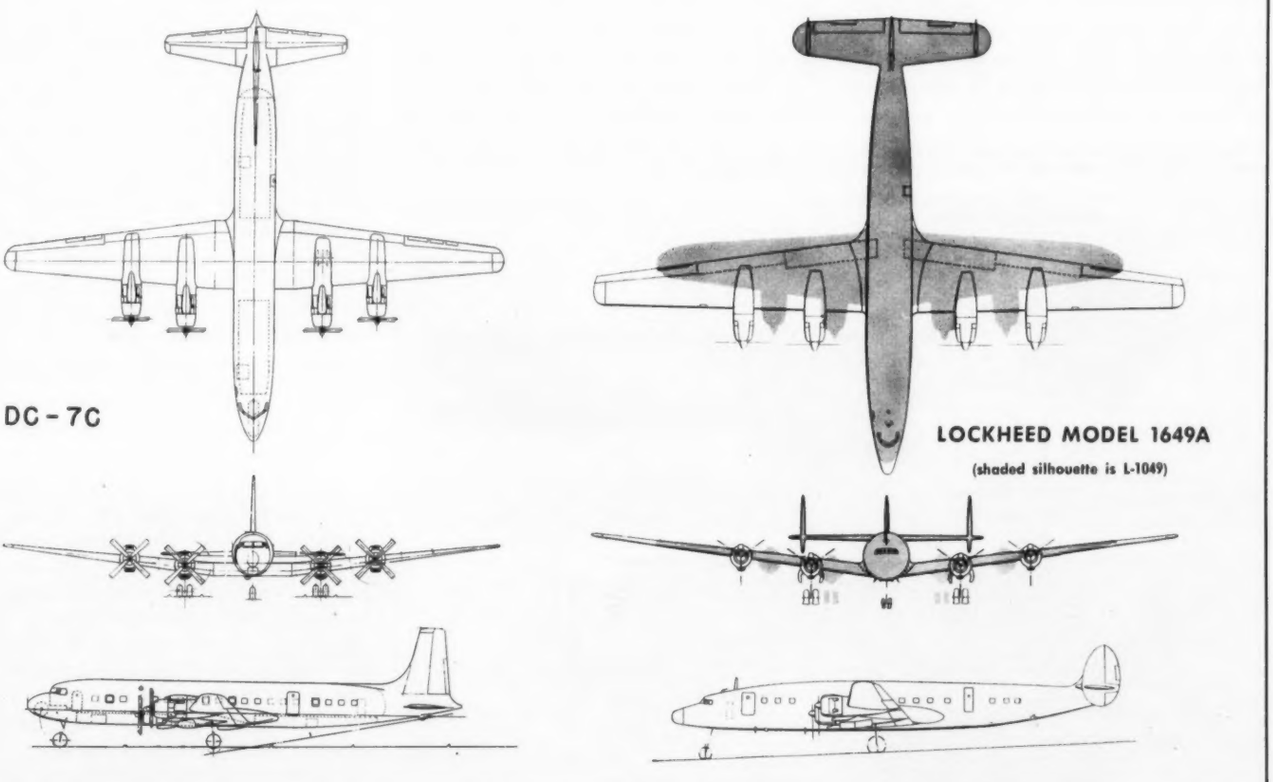
These announcements naturally do not mean that the new aircraft will become available overnight. Flight testing of the Douglas DC-8 is at present scheduled for the end of 1957, so that it could scarcely get into service before 1959. And under present plans deliveries of the Lockheed *Electra* are to begin in 1958.

It is clear, however, that the question of fleet renewals is now becoming acute, and more rapidly than appeared to be the case a few months ago.

If the U.S. air transport industry wishes to cut a good figure in the coming years, it must begin to look around for the necessary funds now.

COMPARISON OF LATEST U.S. LONG-RANGE AIRCRAFT

TYPE	DC-7C	L-1649A	TYPE	DC-7C	L-1649A
Power plant:	Four Wright R-3350 EA-1	Four Wright R-3350 EA-2	**Performance:**		
Take-off power	3,400 h.p. each	3,400 h.p. each	Level speed at rated power	406 m.p.h. (for 107,000 lbs.) 381 m.p.h. (for 139,000 lbs.)	more than 400 m.p.h.
Propeller diameter	13 ft. 6 ins. or 14 ft.	16 ft.	Cruising speed	359 m.p.h. (for 107,000 lbs.) 304 m.p.h. (for 139,000 lbs.)	approx. 350 m.p.h.
Dimensions and weights:					
Span	127 ft. 6 ins.	150 ft.			
Length	112 ft. 3 ins.	116 ft. 2 ins.	Stalling speed	99 m.p.h.	—
Height	30 ft. 9 ins.	24 ft. 9 ins.	Max. rate of climb (at 20,000 ft.)	845 ft./min. (for 107,000 lbs.)	—
Wing area	1,637 sq.ft.	1,850 sq.ft.	Service ceiling	28,000 ft. (for 107,000 lbs.)	—
Aspect ratio	9.85	12			
Max. take-off weight	140,000 lbs.	156,000 lbs.	Range	max. 6,010 miles (with 7,860 U.S. gals.)	max. 6,500 miles (with 9,600 U.S. gals.)
Max. landing weight	107,000 lbs.	123,000 lbs.			
Max. payload	20,083 lbs.	17,000 lbs. (over 4,700 miles)			



Two New Civil Propeller Turbines

ALLISON 501-D10 *and* BRISTOL BE-25

The announcement of British and American projects for future commercial transports has drawn attention to a number of new propeller turbines of medium and high power for civil use. Chief among these are the Allison 501-D 10 (military version T-56) ; Bristol BE-25 ; Rolls-Royce RB-109 ; later versions of the Napier *Eland*.

For example Douglas and Lockheed in the United States have worked out rival designs for four-engined medium-range turboprop transports to replace the *Convair Liner* and to be powered by either the existing Napier *Eland* or the Allison 501-D 10 which is in an advanced stage of testing. The Bristol BE-25, on the other hand, has been designed primarily for later versions of the Bristol *Britannia* long-range transport.

The two most recent of the engines mentioned above—Allison 501-D 10 and Bristol BE-25—are described in brief below.

ALLISON 501-D 10 TURBOPROP

In January 1955 *Harold H. Dice*, General Manager of the Allison Division of General Motors, confirmed that his company had for some time been working on a civil version, the 501-D 10, of the T-56 propeller turbine originally developed for the U.S. Air Force. Since then C.A.A. type testing has been completed, so that a few pre-production models should be available by the end of 1955.

The design principles of both the civil and the military versions correspond in essentials to those of the T-38 predecessor model. Special value has been attached to a low weight/power ratio (0.435 lbs./e.h.p.), ease of installation and maintenance (reduction gear separate from compressor-turbine group), good accessibility of accessories and accessory drives, and adequate safety provision for the event of functional defects in the power plant. Take-off and maximum continuous power are the same as for the T-56 A-1 military version, while climb and cruising power can be adapted within certain limits to the requirements of the various airlines. The maintenance rules recommend an initial operating time of 400 hours between overhauls. Like the T-56, the 501-D 10 is designed to use either jet fuel (JP-4) or 100/130 octane aviation gasoline.

*

At the front of the engine is the *reduction gear housing* (reduction ratio 12.5 : 1), which contains five planet gear wheels, flange for accessories, dry sump oil circuit, a propeller brake (which brakes the propeller when the compressor shaft speed falls below 3,200 r.p.m.), Negative Torque Signal Control System and automatic safety coupling.—The latter serves as an additional safety device and disconnects the gear from the shaft when the engine operates below a given (pre-selected) *negative* torque.

The next component in order is the *air inlet housing*, a one-piece magnesium casting, which houses the front compressor bearing, inlet guide rings and the bevel gear required to provide auxiliary drives. Strut leading edges and inlet guide vanes are de-iced by warm air.—The *14-stage axial compressor*, which follows immediatelv, has a compression ratio in excess of 9 : 1 and handles more than 30 lbs. of air per second. Compressor wheels, blades and vanes, and the horizontally split stator housing are of steel. Eight starting air bleed valves, located on the compressor case at the fifth and tenth stages, are kept open by an electro-magnetic control system at all engine speeds under 13,000 r.p.m. and are designed to prevent compressor surge.—The compressor is followed by the steel *diffuser*, which supports the rear compressor bearing and six fuel nozzles, and provides four ports for bleeding off compressor discharge air.

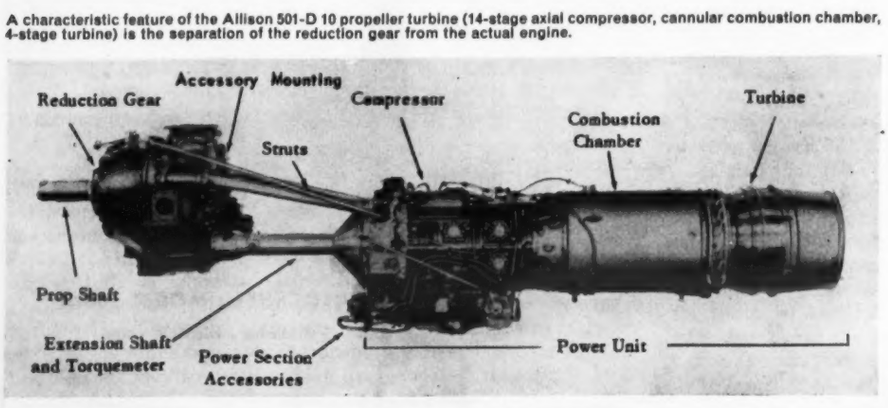
The *cannular combustion chamber* contains six welded liners and two igniter plugs on diametrically opposite liners.—The *turbine inlet casing* houses the front bearing for the *four-stage turbine rotor*. Finally, the turbine *rear bearing support*, together with the *jet pipe*, forms the jet efflux aperture.

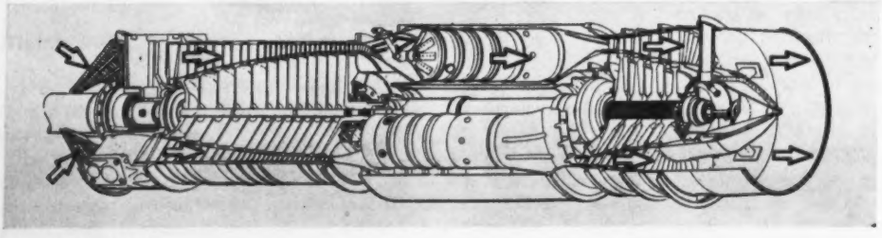
The ignition exciter is a high energy capacitor discharge type dual system operating from the aircraft 28 V d.c. supply. The engine is operated by means of a single lever, acting directly on a *coordinator*, which coordinates the propeller pitch control, electronic temperature datum control and main fuel control. The latter automatically senses compressor inlet pressures, inlet temperatures and compressor speed. Jet exhaust temperature on take-off is approx. 485°C and speed is 700 ft./sec.

*

The makers are now studying methods of still further improving this engine. For example, they are considering reducing the idling speed from 13,370 r.p.m. to 10,000 r.p.m., which would diminish noise level and decrease idling consumption by roughly 20 %. As a further measure to reduce noise the possibility is being considered of raising the gear ratio from 12.5 : 1 to 13.6 : 1, which would reduce cruising propeller speed from 1,106 r.p.m. to 1,009 r.p.m. Finally, to make good the loss of take-off power on hot days,

A characteristic feature of the Allison 501-D 10 propeller turbine (14-stage axial compressor, cannular combustion chamber, 4-stage turbine) is the separation of the reduction gear from the actual engine.





they are investigating the injection of water-alcohol mixture into the combustion chambers.

*

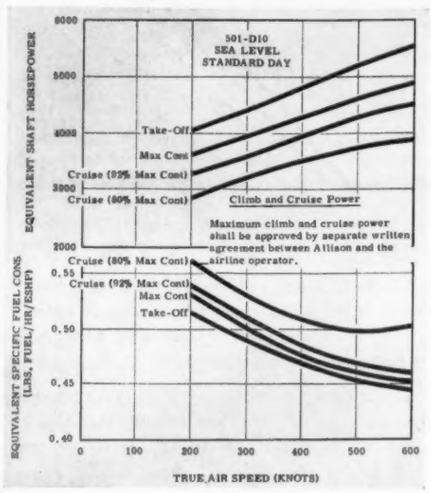
From gear to rear of turbine casing the engine measures 134.4 ins. in length. Its overall width is 21.3 ins., overall height 38.4 ins. and frontal area 6 sq. ft. Dry weight without propeller is 1,630 lbs.

SEA LEVEL PERFORMANCE
(static; standard atmosphere)

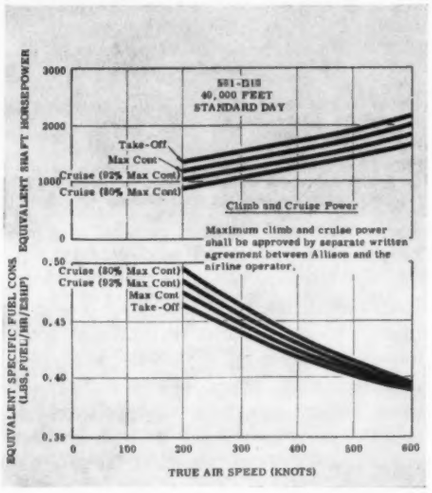
Ratings	r.p.m.	Turbine Inlet Temperature °F	Equivalent s.h.p.	Propeller s.h.p.	Jet Thrust lbs.	Fuel Consumption lb./Hr./e.s.h.p.
Take-Off	13,820	1,780	3,750	3,460	726	0.540
Max. Cont.	13,820	1,700	3,375	3,094	702	0.552
Climb (92 %)	13,820	1,645	3,105	2,830	684	0.566
Cruise (80 %)	13,820	1,557	2,700	2,437	657	0.589
Ground Idle	13,370	—	535	350	452	1.45

DIAGRAMS OF DESIGN PERFORMANCE AND CONSUMPTION FIGURES

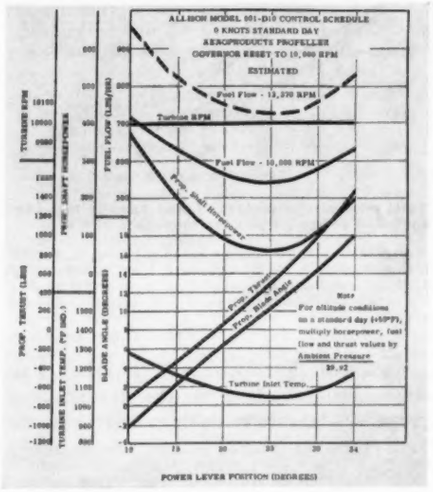
Equivalent shaft horsepower and specific fuel consumption (at sea level; + 15° C) as a function of flying speed (in knots).


501-D10
SEA LEVEL
STANDARD DAY
EQUIVALENT SHAFT HORSEPOWER
Take-Off
Max Cont
Cruise (92% Max Cont)
Cruise (80% Max Cont)
Climb and Cruise Power
Maximum climb and cruise power shall be approved by separate written agreement between Allison and the airline operator.
EQUIVALENT SPECIFIC FUEL CONS. (LBS. FUEL/HR/ESHP)
TRUE AIR SPEED (KNOTS)

Equivalent shaft horsepower and specific fuel consumption (at 40,000 ft.) as a function of flying speed (in knots).


501-D10
40,000 FEET
STANDARD DAY
EQUIVALENT SHAFT HORSEPOWER
Take-Off
Max Cont
Cruise (92% Max Cont)
Cruise (80% Max Cont)
Climb and Cruise Power
Maximum climb and cruise power shall be approved by separate written agreement between Allison and the airline operator.
EQUIVALENT SPECIFIC FUEL CONS. (LBS. FUEL/HR/ESHP)
TRUE AIR SPEED (KNOTS)

Fuel flow (top; in lbs./hr.) and propeller pitch (bottom; in degrees) versus power lever setting (in degrees), under normal day conditions and at zero flying speed.


ALLISON MODEL 501-D10 CONTROL SCHEDULE
0 KNOTS STANDARD DAY
AEROPRODUCTS PROPELLER
GOVERNOR RESET TO 10,000 RPM
ESTIMATED
Fuel Flow - 13,370 RPM
Turbine RPM
Fuel Flow - 10,000 RPM
Prop. Shaft Horsepower
Prop. Thrust
Prop. Blade Angle
Turbine Inlet Temp.
Note
For altitude conditions on a standard day (+15°F), multiply horsepower, fuel flow and thrust values by Ambient Pressure / 29.92
POWER LEVER POSITION (DEGREES)

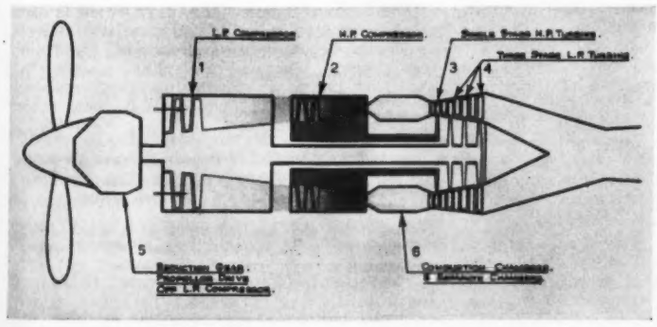
THE BRISTOL BE-25 PROPELLER TURBINE

The guiding principle in the design of the Bristol BE-25 twin-compressor engine was the demand for very low fuel consumption figures, approaching those of the most economical compound engines. The specification also called for a cruising power of approx. 3,500 h.p. at altitudes of about 30,000 ft. Finally the new engine was to deliver a constant take-off power of 4,000 s.h.p. under all climatic and topographical conditions.

Following the recent announcement that the BE-25 is designed primarily for installation in future versions of the Bristol *Britannia* four-engined long-range aircraft, the Bristol Aeroplane Company has published first details of this engine, which has meanwhile been ordered in quantity. These reveal that it combines design characteristics of the proven *Proteus* turboprop and the two-spool *Olympus*.

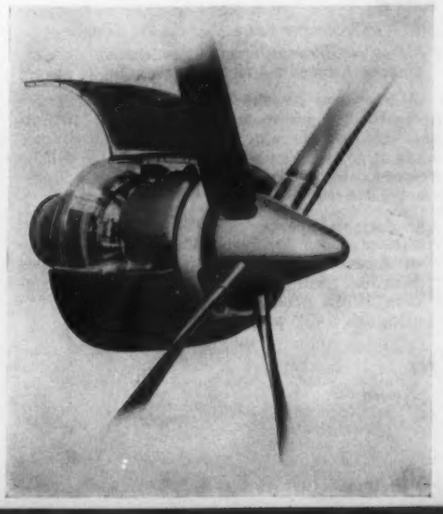
*

In the main the BE-25 consists of the following components: low pressure and high pressure compressors, both of axial type; eight combustion chambers; single-stage high pressure turbine; three-stage low pressure turbine.—The separation of the high and low pressure stages of the compressor enables a *compression ratio of 10:1* to be obtained and thus produces exceptionally low specific fuel consumptions. The (forward) low pressure compressor is coupled to the propeller drive and feeds the high pressure compressor with partly compressed air, thus acting to a certain extent merely as a supercharger. The high pressure compressor works only within a closely limited speed range, i.e., at optimum efficiency, while the low pressure stage connected to the propeller can operate at very different rotary speeds (take-off, climb and cruise). This arrangement above all simplifies engine regulation. It also reduces starting torque, as propeller, reduction gear and low pressure stage are

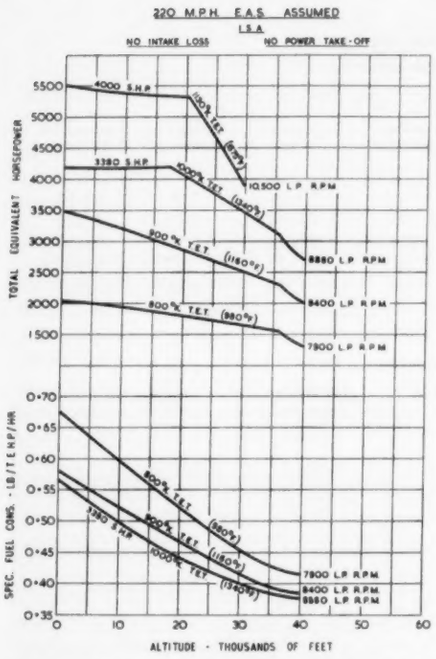


Structure of the Bristol BE-25

1 — low pressure compressor; 2 — high pressure compressor; 3 — single-stage high pressure turbine; 4 — three-stage low pressure turbine; 5 — reduction gear (on same shaft as low pressure compressor and low pressure turbine); 6 — eight combustion chambers.

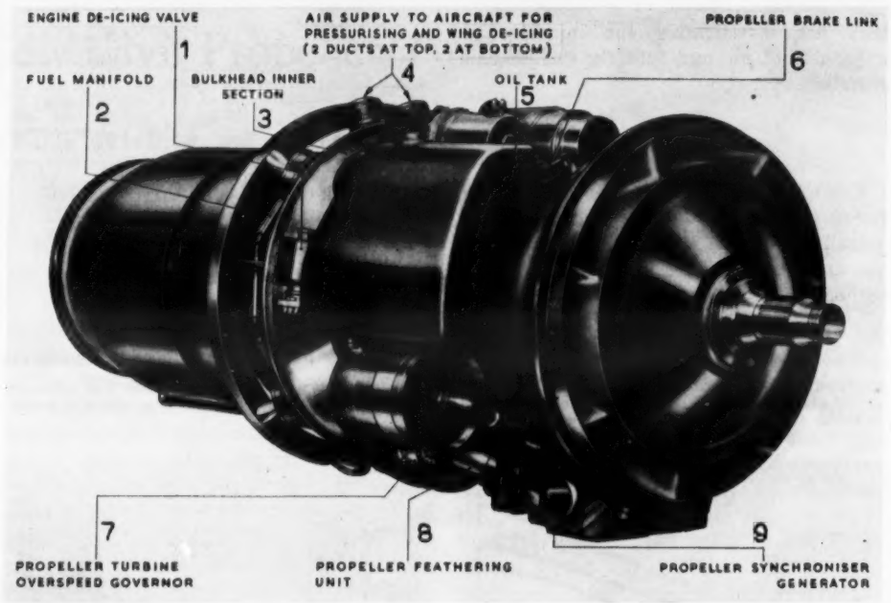


The complete BE-25 with de Havilland four-blade propeller.



Total equivalent horsepower and specific fuel consumption versus altitude (in thousands of ft.):

at an altitude of 25,000 ft. and a speed of 220 m.p.h., specific fuel consumption, for an equivalent shaft horsepower of 4,200 h.p., reaches the unusually low figure of 0.42 lbs./hr./h.p., which approaches the values for diesel and compound engines.



The Bristol Aeroplane Company plans to supply the BE-25 as a complete power plant (with de Havilland 16-ft. v.p. propeller): length roughly 108 ins.; diameter roughly 40 ins.

not affected. Finally, drag in the event of an engine failure—due to the wind-milling propeller—is substantially reduced, as the high pressure stage is not mechanically coupled with the propeller shaft.

•

Described as a " constant-power " turboprop, the BE-25 is so designed that it delivers the same power of approximately 4,000 s.h.p. from sea level up to about 20,000 ft. An additional 1,300 to 1,500 h.p. power is supplied by the exhaust thrust. This constant power provides a decisive advantage compared with other propeller turbines, whose performance falls off appreciably at high-altitude airports and at high ambient temperatures. It is obtained because the BE-25 corresponds to a normal 8,000 h.p. engine, but its power is torque limited to approx. 4,000 h.p. up to an altitude at which a normal engine would have dropped to 4,000 h.p., after which it begins to fall off in the usual way. At 30,000 ft. it still delivers about 3,800 e.h.p., however, which is almost double the power of an ordinary 4,000 h.p. turboprop at this altitude.

Despite the inclusion of two compressors, the dimensions and weights of the BE-25 have been kept down to the same general level as for the *Proteus*. The Bristol Aeroplane Company plans to supply the engine as a complete power plant, fully equipped and with cowling and four-blade propeller.

Book Reviews

Fédération Aéronautique Internationale — Cinquante Années d'Aviation. (French ; 24 pages)

A brochure by the international federation of sports flying associations to mark its fiftieth anniversary. It contains an admirably concise account of the Federation's history and will be welcomed by all sport flyers. He.

The Aircraft Year Book 1954 — Official publication of the Aircraft Industries Association of America. 36th year. Compiled by Fred Hamlin, Lynn Black, Eleanor Thayer. Lincoln Press Inc., Washington D.C., 1955 (English ; 472 pages ; price $ 6).

The Aircraft Year Book of the Aircraft Industries Association naturally needs no recommendation. Anyone who has to deal with military or civil aviation in the United States needs this book within reach at all times. It includes a complete review of the U.S. aircraft industry's production in 1954 (aircraft and guided missiles, engines, accessories ; with photographs and three-view drawings) ; an air transport report ; chronicle of aeronautical events ; 1,200 biographical notes ; list of records, etc. He.

L'Aviazione Civile Italiana — Published by the Italian Defence Ministry (Ufficio Stampa del Ministro della Difesa), Rome, 1955 (Italian, 55 pages).

The Italian Defence Ministry, which is also responsible for civil aviation, gives in this well illustrated brochure a comprehensive picture of the present position in Italian commercial aviation ; airlines ; operating performance ; ground organization ; cooperation with other transport branches, etc. He.

Two booklets published by the German Institute for Air Transport Statistics (Institut für Luftverkehrsstatistik), Frankfurt/Main :

Entwicklung des Luftfrachtgeschäfts nach 1945. Frankfurt a. M., 1955 (German ; 77 pages).

The letter from the newly-created Frankfurt Institute for Air Transport Statistics which accompanied two of the Institute's publications

states, " these two brochures make no claim to be scientific achievements. They are rather to be regarded as first signs of life of a newly-founded Institute anxious to furnish its economic supporters, in particular the municipal corporations, with informatory reports."—In this, the Institute is too modest. The present booklet gives a remarkably good survey of the post-war development of international air freight business and provides both practical and theoretical workers in Germany's revived air transport with intelligently selected material on organizations, companies and transport performance in all countries.

Der Flughafen Frankfurt am Main in Gegenwart und Zukunft — The Problems of a Major Airport.—Frankfurt a. M., 1955 (German ; 57 pages).

Using the post-war development of Frankfurt Airport—which plays a constantly growing part in European air transport—as an example, this booklet examines all the requirements and difficulties which large modern airports may expect to face in the coming years : increase in traffic volume, installations for flight operations, for traffic handling, and maintenance, ground transport periods, economic problems, feeder services, etc. Well arranged tables and graphs in the supplement. He.

Air Touring Guide to Europe 1955-56.—Issued by the Royal Aero Club Aviation Centre, London (English, 223 pages, price 10 shillings)

Interavia's editors feel they can do no better than repeat in full the recommendation with which they have welcomed earlier editions during the past five years (and part of which now appears on the dust cover of this handbook) . . . *in full,* since unfortunately the " International Aviation Vocabulary " (p. 40, etc.) still contains the same errors. " Navigation " is still translated into German as " Schifffahrt " (which means " shipping "), a " pilot " is still given as " Lotse " (a ship's pilot), the French for " change " is " jonnaie " (a misprint for " monnaie ") etc . . . If this continues Interavia's German editors will soon find themselves using these false expressions. He.

Probleme der Weltraumforschung. — The complete collection of the papers read at the Fourth International Astronautical Congress in Zurich. Issued by the Swiss Astronautical Society for the International Astronautical Federation. Publishers, Laubscher & Cie., Basle.

The results of the Fourth International Astronautical Congress held at the Federal Institute of Technology, Zurich, from August 3rd to 8th, 1953, were discussed in detail in *Interavia* No. 11, 1953, an issue devoted to rockets. There is therefore little to add here, except to state that the full text of the 28 papers read by international space travel experts is now available. Credit should be given, however, for the great care with which the lectures have been presented and illustrated. The directing hand of Professor J. Ackeret (Federal Institute of Technology, Zurich), who organized the Congress, is unmistakable. He.

ABC British Military Aircraft ; ABC Continental Military Aircraft. Two volumes in the " Aircraft ABCs " series by John W. R. Taylor. Published by Ian Allan Ltd., London, 1955 (English, 75 pages each, price 2s. 6d. each).

New, improved editions of two volumes in this popular series designed primarily for aircraft spotters. Aircraft types are arranged in alphabetical order according to manufacturers and include all models in service or projected for the Royal Air Force and Fleet Air Arm in the first case, and European air forces, including Iron Curtain countries, in the second. Each aircraft is given a photograph, three-view silhouettes and brief details of characteristics, recognition features, duties, etc. In short, very handy little books for all interested in aircraft recognition.—Other volumes in the series : ABC Civil Aircraft Markings, ABC British Civil Aircraft, ABC of Helicopters. St.

Die Grenzen der Schlechtwetter-Landetechnik und ihre Auswirkung auf den Luftverkehr (Volume 32 in the series of " Technical and Economic Reports " issued by the North Rhine-Westphalia Ministry of Economics and Transport. Edited by Under-Secretary of State Professor Brandt).—By Dr.-Ing. Hans J. Zetzmann, printed in manuscript form, 1955. (German ; 98 pages ; price DM 10).

In the stage of technical development so far reached, bad weather landings can be made only down to given weather minima (in general cloud base at least 200 ft., horizontal visibility more than ½ mile). Pure blind landings, in which the pilot has no sight of the ground until he touches down, are still not possible in air transport.—The author, a member of the Oberpfaffenhofen Aeronautical Radio Research Institute and a well-known expert on air traffic and airway control, examines the factors involved and attempts to determine what steps could be taken to reduce today's weather minima with the object of arriving at completely blind landings. He concludes that the following developments are needed : 1) improvement of approach control aids ; 2) automatic course and position adjustment down to touch-down and during taxying ; 3) observance of " touch-down criterion ", e.g., by the introduction of a radio-electric altimeter ; 4) adaptation of airport approaches to ensure reliable electrical altitude measurements ; 5) introduction of an additional guidance system for touch-down and taxying.

The book shows that progress in instrument landing procedures cannot be obtained by advances in isolated branches of aeronautical engineering, but need the cooperation of all. Moreover, an analysis of costs proves that the introduction of 100 % all-weather landings will necessitate extensive investments. Ri.

Die Funkmessgeräte der deutschen Flakartillerie 1938-1945. By A. E. Hoffmann-Heyden. — Volume 3 in the German Radio Navigation Committee's " Bücherei der Funkortung ". Edited by Prof. L. Brandt. Published by Verkehrs- und Wirtschafts- Verlag G.m.b.H., Dortmund, 1955. (German, 298 pages, 180 illustrations, price DM 19.50).

Major Hoffmann-Heyden, former head of the Luftwaffe's military-technical Anti-Aircraft Radar Test Group is already known to *Interavia* readers : in the November 1951 issue he wrote an article entitled " German Radiolocation in Retrospect ", with special reference to the anti-aircraft artillery's radar equipment, giving a clear account of the first and last German developments in this important section of air defence. The same purpose is served, on a much broader scale, by the present book, which gives technical details, circuit diagrams and photographs of some dozen anti-aircraft radar equipments and the associated recognition equipment for German combat aircraft.

Through all the technical details there is still a clearly discernible echo of the dramatic, invisible " high frequency war " between Germany and the Western Allies. As Professor Brandt says in his foreword : " . . . in the interaction between the introduction of the first radar equipment, enemy jamming measures, counter-measures and development of new equipment (echoes) the suppressed tension of this intellectual life or death struggle."—Yet the author's intention was not " to awaken unpleasant reminiscences, but to recall good memories of work on one of the most interesting measuring systems of the present time." Ri.

The Self-Examining Handbook for Pilots and Navigators (2nd Edition).—By E. Brook Williams and C. W. Roberts.—Published by International Aeradio Ltd., London, 1955. (English ; 319 pages).

Contains a great many examination questions —and their answers when figures are involved— such as might be asked of candidates for commercial pilots' and navigators' licences. Matter is dealt with under the following main headings : trigonometry, charts, meteorology, flight planning, radio navigation, astronomic navigation. —The book is a valuable aid for prospective commercial pilots (with instrument rating), airline transport pilots and navigators. Ri.

The Observer's Book of Weather.—By Reginald M. Lester. Frederick Warne & Co., Ltd., London & New York, 1955 (English ; 151 pages ; 64 plates, 16 in colour ; glossary, tables ; price 5s.).

This volume, in the same series and of the same pocket format as " The Observer's Book of Aircraft ", and written for the amateur weather observer, contains a complete description in non-technical language of all the basic elements going to make up the weather, the instruments used for measuring and forecasting, the preparation of weather maps and the basic problems of weather forecasting.

Keen amateur observers have made a valuable contribution to weather research, and the monthly report of Britain's Meteorological Office is based to a surprisingly large extent on the observations of volunteers. This little book seeks to interest still others in what the author, himself an enthusiast of many years' standing, describes as a fascinating and worthwhile hobby. St.

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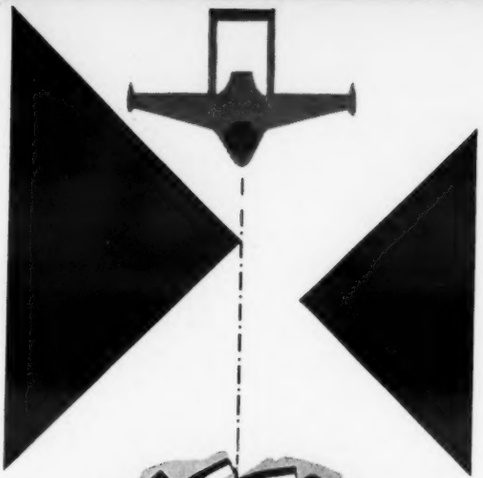
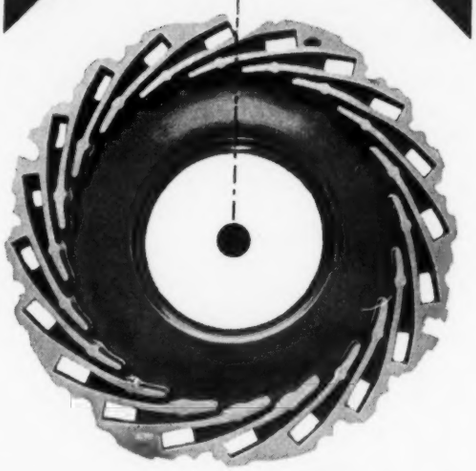


Front diffusor for the jet engines in the "Venom" (de Havilland licence.)



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KLM is the first to make use of air-cooled engines and all-metal propellers, also since 1920 the first to introduce to the world the Fokker passenger planes which later on became the most widely used commercial aircraft in the world.

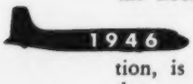
1927 KLM makes the world's first intercontinental charter flight: Amsterdam-Jakarta and -Khartoum.

KLM opens the longest air route in the world of that time: Amsterdam-Jakarta.

KLM, as first airline outside the U.S., introduces the all-metal DC-2, wins the London-Melbourne Air Race handicap section.

1936 KLM is the first European company to purchase the world's most widely sold commercial aircraft: the DC-3.

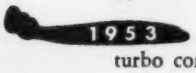
1943 KLM, as first non-U.S. carrier, orders the Lockheed Constellation.



KLM, despite its war-shattered organization, is the first European airline company after the war to open a regular Trans-atlantic service to New York.

1948 KLM is the first European company to put the Convair Liners into service.

1950 KLM is the first European airline to be specially authorized by the U.S. Government to overhaul aircraft of U.S. airlines.



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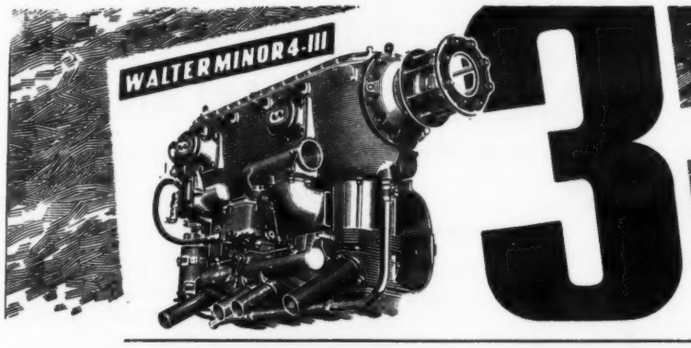

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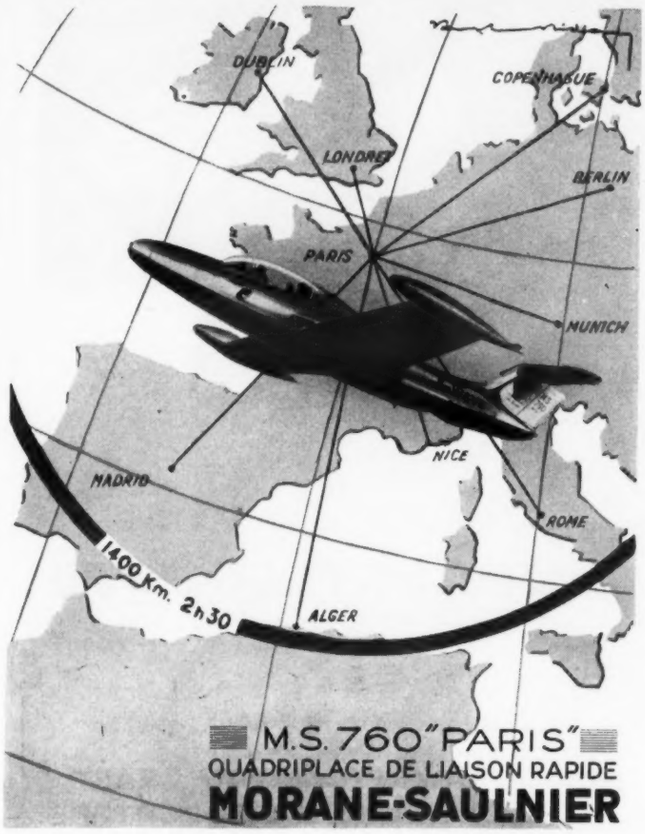

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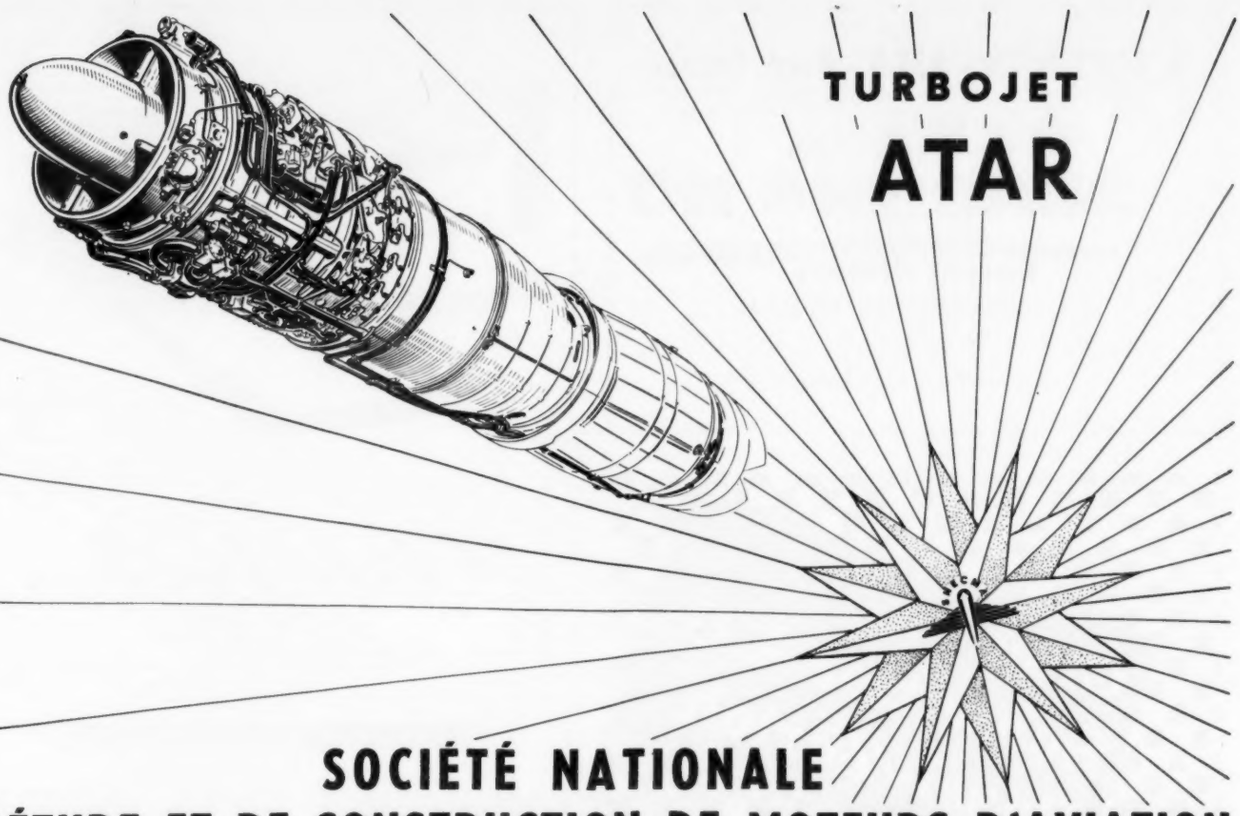

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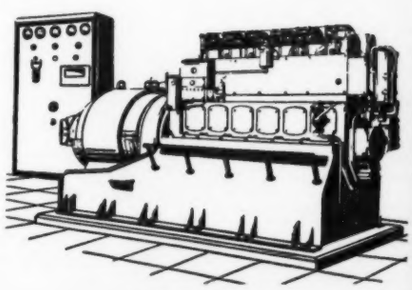

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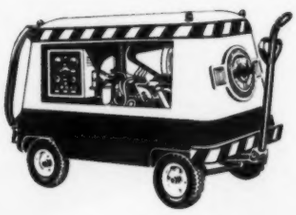

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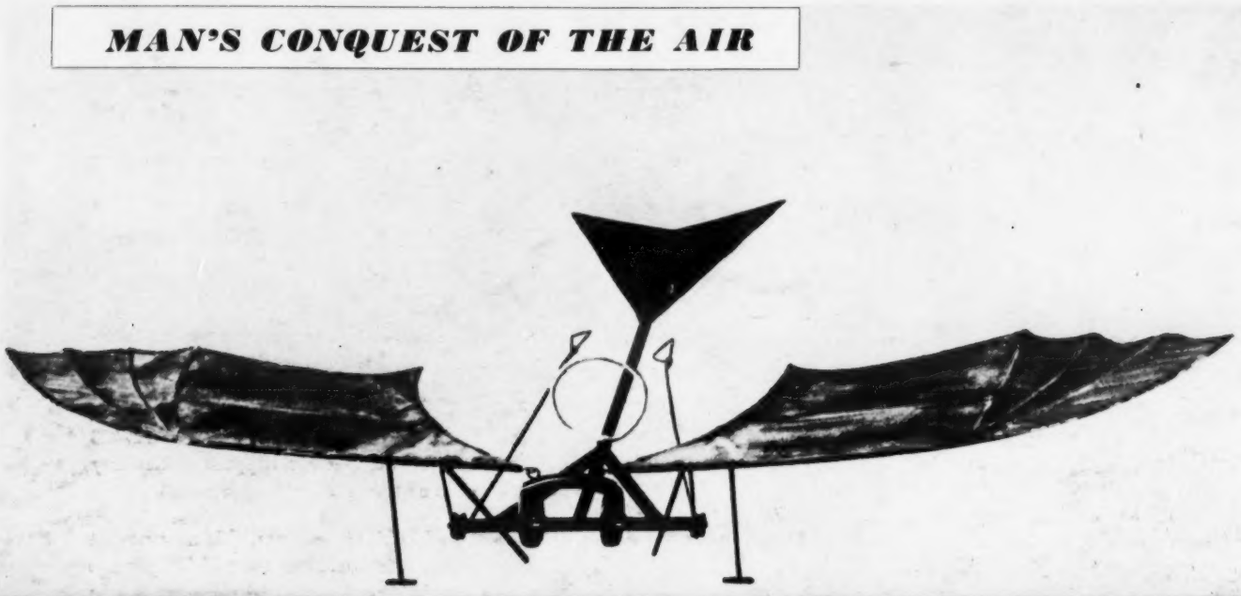

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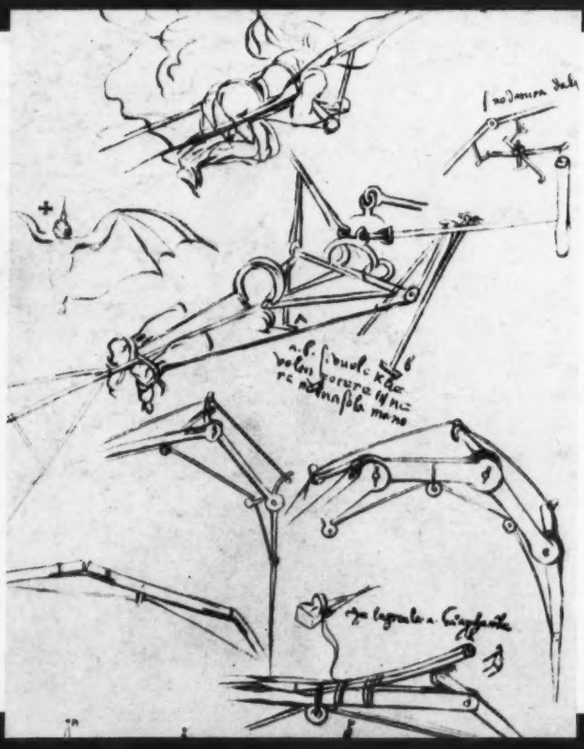

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